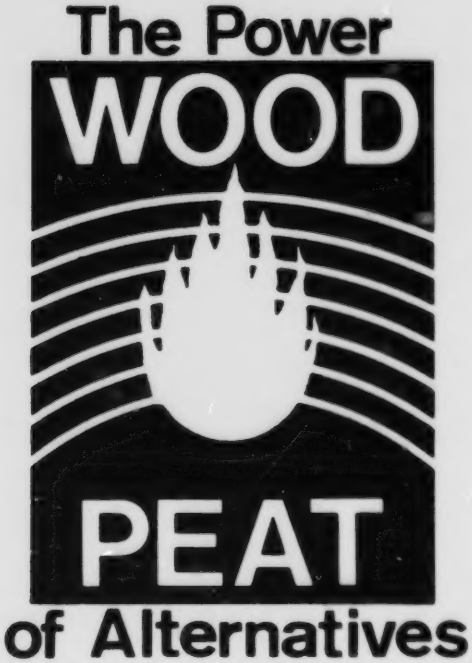

Hotel Gander
Gander, Newfoundland
November 17-19, 1986

Conference Papers

89-01972/

CONFERENCE PAPERS

The Power of Alternatives:
Energy from Wood and Peat

Department of Mines and Energy
Government of Newfoundland and Labrador
Hon. Jerome Dinn, Minister

FOREWORD

The future development of offshore oil fields, such as Hibernia, will increase our prosperity significantly, through both revenues and employment. But this conference is about other sources of energy within the province which can be cheaper than oil, even at today's low prices.

In Newfoundland and Labrador, we have two major non-fossil fuels: wood and peat.

We could burn half a million tonnes of "uncommercial" wood as woodchips each year for industrial fuel. And we could continue to do so indefinitely. Harvesting and maintenance would employ about 350 people permanently and reinvest millions of fuel dollars annually into our economy. Many more seasonal jobs would be created to convert existing boilers and construct new ones. Our paper and lumber industries would benefit from improved forest management and from the availability of new areas for growing commercial timber. At the bottom line, the fuel costs of converted boilers can be low enough to generate significant savings over the cost of oil. If there is an accessible supply of woodchips and waste wood any investment in woodburning equipment can be repaid in a relatively short time.

In most regions where wood is in short supply, there is peat. An estimated 11 per cent of the area of the province is peatland. Fuel-grade peat on the Burin Peninsula could meet all local residential and commercial energy needs for two hundred years. The Avalon, Northern Peninsula and Stephenville areas also have considerable peat reserves. Once fuel reserves are harvested the land can be easily reclaimed for agriculture or recreation.

"The Power of Alternatives" was organized to bring together those who have gained first-hand experience in the use of woodchips and peat as fuel in the province, and you, the potential new participant in this viable new industry. By harvesting and burning these alternative fuels we can gain a measure of independence from the uncertainty of world oil prices. I hope you enjoy the conference, and that it will further your interest in our alternative fuels.

THE HONOURABLE JEROME W. DINN
Minister of Mines and Energy
Government of Newfoundland
and Labrador

PREFACE

This report was prepared to provide an overview of the presentations at this conference. It is not intended to be a word-for-word copy of what was said.

Due to technical difficulties the presentations of: Bill Fleck, Newfoundland and Labrador Development Corporation; Bill Buggie, Department of Forest Resources and Lands; Mayor Ross Sheppard, Town of Badger; John T. Drover, Department of Mines and Energy; Nat French, Energy, Mines and Resources Canada; and Don Finch, Provincial Consultants, are not included in this report. We apologize for any inconvenience this may cause.

DISCLAIMER

"This publication was funded by the Newfoundland and Labrador Department of Mines and Energy. Distribution of the report by the department does not necessarily signify that the contents reflect the views and policies of this department. Any mention of trade names or commercial products does not constitute recommendation or endorsement for use".

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Biomass Fuels for Industrial, Commercial and Institutional Use

A Provincial Perspective

for the

Wood and Peat Energy Conference

November 18, 1986

Report Presented By:

Philip M. Graham, P. Eng.
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Biomass Fuels for Industrial, Commercial and Institutional Use; A Provincial Perspective

October 1986

Background

The use of woodchip fuel in Newfoundland's buildings and plants began with the CREDA program in 1980 (Conservation and Renewable Energy Demonstration Agreement). Eleven demonstration projects have proven the technical and economic viability of the combustion of green chips and introduced the technology to many potential chip suppliers and users. CREDA projects included new wood boiler installations at Gander Hospital in 1983, Newfoundland Hardwoods in 1984 and Clarenville District Vocational School in 1985. These three projects are shown in Table 1 in the attachments. The combined woodchip demand is 10,000 green tonnes per year yielding fuel savings of $360,000 per year at 1985 prices. Combined capital cost was $1.8 million.

Since 1978 the commercial viability of woodchip harvesting equipment and methods has been successfully demonstrated at the Corner Brook and Grand Falls paper mills (with initial assistance from the Energy From Forest Program) and by harvesting trials run by the Department of Forest Resources and Lands (under the

Forestry Subsidiary Agreements). Table 1 shows impressive results for the paper mills, 63,000 tonnes of chips burned in 1985, resulting in fuel savings of approximately $2.1 million. The initial capital investment was $1.5 million for chip harvesting equipment.

The CREDA program also initiated two major fuel peat harvesting projects, milled peat at Bishop's Falls and sod peat at St. Shotts. Results show that for adequately drained bogs, peat can be air dried in summer to produce a marginally economic fuel. More work needs to be done to optimize bog drainage and equipment and establish costs and reliability of supply before fuel peat could be produced commercially for large heating plants. Sod peat for burning in stoves and fireplaces however is proving to be fairly popular.

Building on the results of past years, the Provincial and Federal Governments have earmarked $2.6 million this year and next for woodfuel and fuel peat projects under the Memorandum of Understanding on Conservation and Alternative Energy. Some projects are run independently such as the woodchip conversions of the Corner Brook and Grand Falls Hospitals (by the Province) or the study of the Gander Armed Forces Base and Airport (by Canada). Many projects however are being run jointly by both governments including studies, information activities (such as this conference) and smaller scale demonstration projects.

Future Prospects

Since the late 1970s we have established harvesting and burning methods and technologies which are technically feasible and economically attractive. We also realize that there is still tremendous scope for biomass fuels in the province. Many of the best projects have not yet been done and these represent a significant economic development opportunity.

A 1985 study by the Energy Branch (Potential Impact of Energy Conservation and Alternative Fuels in Newfoundland and Labrador, 1985-1995) estimated the investment required and the impacts of implementing all of the better biomass fuels projects with simple paybacks averaging four years. The analysis was based on the prevailing oil price of $28 U.S./bbl. The results are presented in the attachments. Total investment required is an estimated $110 million. This would result in fuel savings of approximately $30 million per year and would generate 12,000 person years of employment over the life of the projects undertaken (equivalent to 600 permanent jobs).

Even if oil prices over the next decade returned to high levels, it would be difficult to achieve this total investment. On the other hand, at today's oil price of $15-$20 U.S./bbl many of the projects are still viable.

More could be done to encourage the use of chips (and fuel

peat) and thereby increase the resulting benefits of cost savings for heating plant owners, employment and better forest (and peat bog) utilization. Possible measures by government are listed in the attachments including ways to promote new biomass burning plants by private companies, conversions of provincially owned facilities and investigation of financing mechanisms.

The listing of possible government measures is accompanied by Tables 2 and 3, Prospective Projects by Others and Recommended Projects by the Province. Total estimated wood and peat demand for these projects is seen to be 465,000 green tonnes per year yielding annual fuel savings of $15.4 million at 1985 oil prices or $8.6 million at today's oil prices. Total capital cost is an estimated $52.9 million.

It should be noted that 1. the possible government measures listed are not Provincial Government policy, 2. the figures for some projects are rough approximations only, notably the three pulp and paper mills and Roddickton electricity generation, 3. projects are looked at from government's as opposed to the companies' perspective (incentives needed, employment benefits, etc), 4. no intent is implied on the part of plant owners to implement these projects.

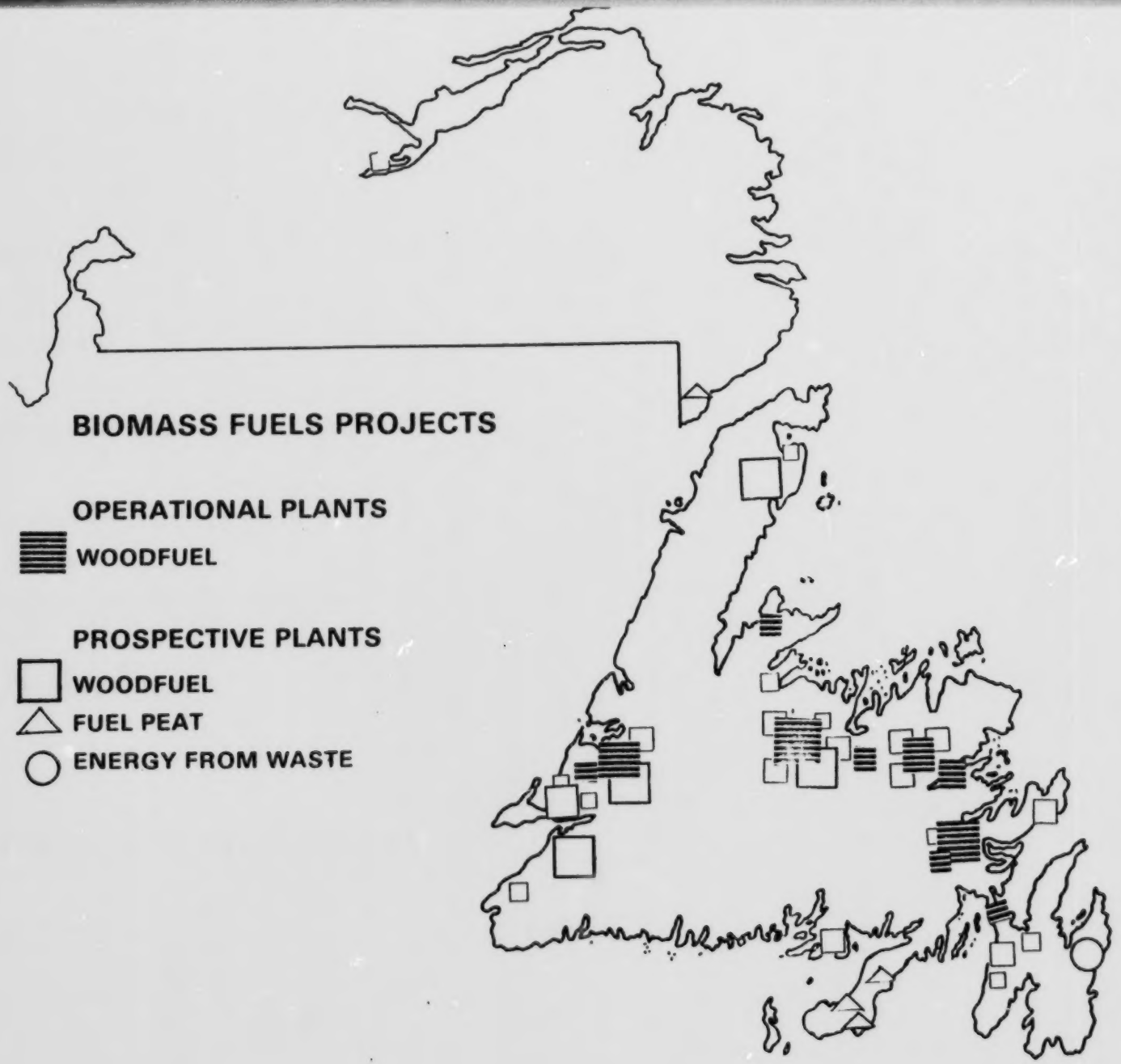
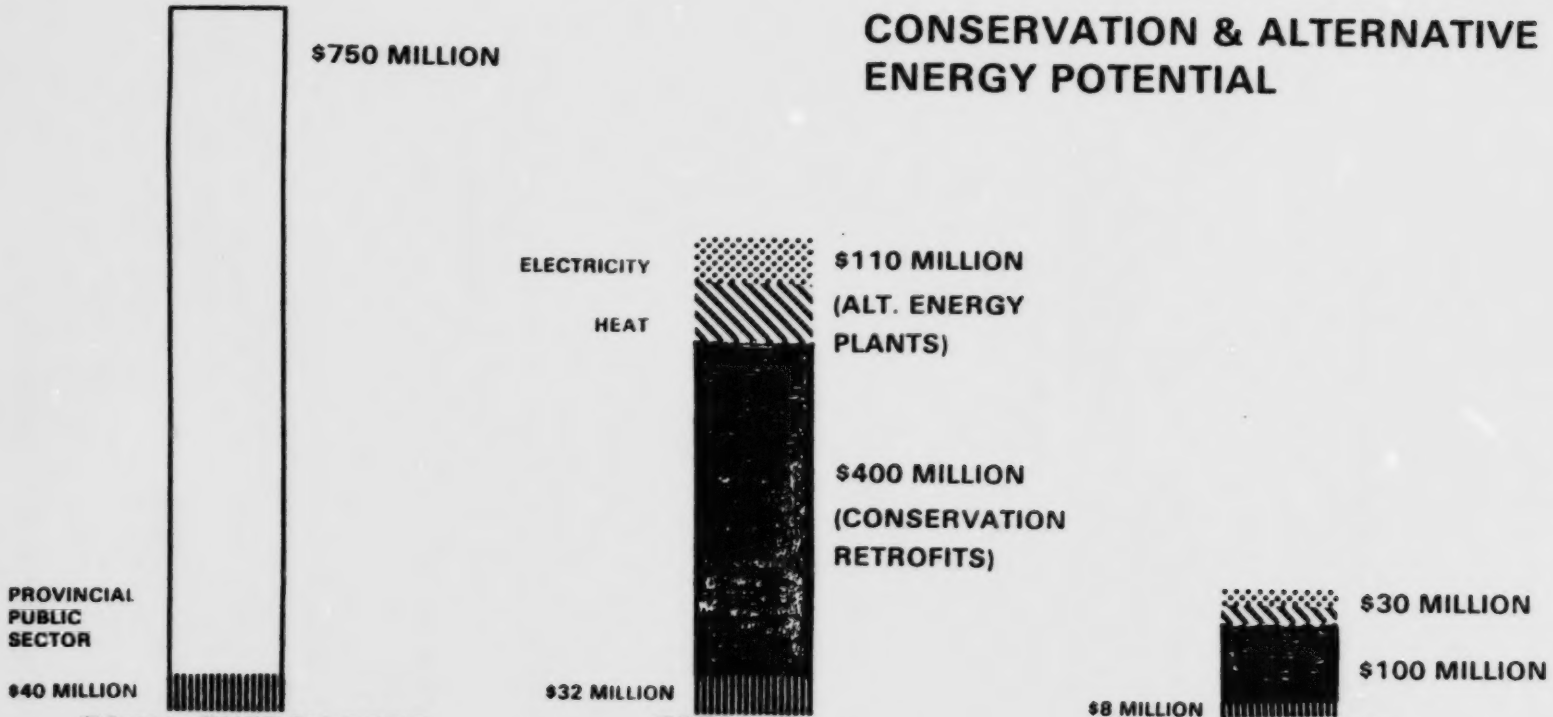

BIOMASS FUELS PROJECTS
OPERATIONAL PLANTS
WOODFUEL
PROSPECTIVE PLANTS
WOODFUEL
FUEL PEAT
ENERGY FROM WASTE

TABLE 1

OPERATIONAL WOODFUEL PLANTS

	000T/YR WOOD	PERM JOBS	TOTAL COST $000	FUEL SAVINGS/YR, $000 $28 US/BBL	$20 US/BBL
1. GANDER HOSPITAL	3	2	995	120	45
2. NFLD. HARDWOODS, CLARENVILLE	6	4	615	200	70
3. CLARENVILLE VOCATIONAL SCHOOL	1	1	200	40	25
4. ABITIBI, GRAND FALLS	48	30	805	1,600	570
5. KRUGER	15	10	700	500	180
SUB-TOTAL	73	47	3,315	2,460	890

CONSERVATION & ALTERNATIVE ENERGY POTENTIAL



IMPACTS OF INVESTMENT

1. ENERGY COST SAVINGS
(AT 1985 ENERGY PRICES)

	NFLD. COMPONENT
$130 MILLION/YR	100%

2. EMPLOYMENT

		NFLD. COMPONENT
TEMPORARY JOBS (PERSON YEARS)	23,500	37%
PERMANENT JOBS	350	100%

3. ECONOMIC ACTIVITY

	NFLD. COMPONENT
$970 MILLION TO GNP	50%

4. GOVERNMENT TAX REVENUES

	PROV. COMPONENT
$135 MILLION	10%

5. ENVIRONMENTAL CLEAN-UP

POSSIBLE GOVERNMENT MEASURES

1. PROMOTION OF THE BIOMASS BURNING PLANTS OWNED BY OTHERS LISTED IN TABLE 2 BY MEANS OF

- FEASIBILITY STUDIES
- GRANTS & LOAN GUARANTEES
- HIGH ELECTRICITY BUY-BACK PRICE
- FUELWOOD RESOURCE MANAGEMENT
- FUEL PEAT SUPPLY DEVELOPMENT

STUDIES

- FUNDING FOR FEASIBILITY STUDIES OF BIOMASS BURNING PLANTS

PROJECT FUNDING

- INCENTIVE GRANTS TO THE COMPANIES FOR PROJECTS PLUS LOAN GUARANTEES (ALTERNATIVELY LOW INTEREST LOANS)

ELECTRICITY

- ESTABLISHMENT BY NEWFOUNDLAND AND LABRADOR HYDRO OF A HIGH BUY-BACK PRICE AT OR NEAR MARGINAL COSTS TO COMPANIES FOR BIOMASS-GENERATED POWER

FUELWOOD RESOURCE MANAGEMENT

- DEVELOPMENT AND IMPLEMENTATION OF FUELWOOD RESOURCE MANAGEMENT POLICY BY FOREST RESOURCES AND LANDS TO ENCOURAGE COMMERCIAL FUELWOOD SUPPLY

FUEL PEAT SUPPLY DEVELOPMENT

- CONTINUED FUNDING FOR THE NEXT 3 YEARS FOR PEAT RESOURCE INVENTORIES AND DRAINAGE & HARVESTING TRIALS TO ESTABLISH THE COMMERCIAL VIABILITY OF PEAT AS AN INDUSTRIAL FUEL (FOR AREAS LACKING FUELWOOD)
- SUPPORT FOR A PROGRAM OF BOG DRAINAGE AND SOD PEAT "PLOTTING" FOR RESIDENTIAL USE

2. IMPLEMENTATION FOLLOWING DETAILED STUDY OF THE NINE PROVINCIALLY OWNED BIOMASS BURNING PLANTS LISTED IN TABLE 3

3. ASSESSMENT OF SOLID-FUEL BOILERS FOR ALL NEW PROVINCIALLY OWNED BUILDINGS

4. INVESTIGATION OF FUNDING/FINANCING MECHANISMS INCLUDING:

- FUNDING MECHANISMS
- SAVINGS FINANCING
- FEDERAL FUNDING

- ASSESSMENT OF FUNDING MECHANISMS FOR PROVINCIALLY OWNED ENERGY CONSERVATION PROJECTS AND BIOMASS BURNING PLANTS

- ASSESSMENT OF BOTH PUBLIC & PRIVATE SAVINGS FINANCING MECHANISMS BY MINES & ENERGY

- DESIGNATION OF BIOMASS FUELS AS AN ECONOMIC DEVELOPMENT PRIORITY FOR FEDERAL - PROVINCIAL FUNDING AGREEMENTS

TABLE 2

PROSPECTIVE PROJECTS BY OTHERS

WOODFUEL PLANTS	000T/YR WOOD	PERM JOBS	TOTAL COST $000	FUEL SAVINGS/YR $000	
				$28 US/BBL	$20 US/BBL
1. ABITIBI, STEPHENVILLE	100	60	10,600	3,400	1,800
2. ABITIBI, GRAND FALLS	100	60	10,600	3,400	1,800
3. KRUGER	100	60	10,600	3,400	1,800
4. ERCO	15	10	1,200	440	160
5. GANDER BASE AND AIRPORT	12	8	1,600	500	180
6. FPI, CATALINA	8	5	900	400	280
7. FPI, HARBOUR BRETON	6	4	800	300	200
8. SMALL SCALE PLANTS	25	25	3,000	1,250	900
FUEL PEAT PLANTS					
9. FPI, TREPASSEY, MARYSTOWN, FORTUNE	15	10	3,300	750	490
TOTAL	381	182	42,600	13,840	7,610

TABLE 3

RECOMMENDED PROJECTS BY THE PROVINCE

WOODFUEL PLANTS 1986	000T/YR WOOD	PERM JOBS	TOTAL COST $000	FUEL SAVINGS/YR $000	
				$28 US/BBL	$20 US/BBL
1. CORNER BROOK HOSPITAL, WOOD BOILER	9	6	1,000	340	120
2. GANDER VOCATIONAL SCHOOL, PIPELINE	2	1	360	130	90
3. WOODALE TREE NURSERY, WOOD BOILER	2	1	400	80	55
4. PORT HOPE SIMPSON, INST. WOOD HEAT	1	1	250	30	25
5. RODDICKTON, ELECT. GEN	60	40	5,000	500	400
6. GRAND FALLS HOSPITAL WOOD BOILER	4	2	600	190	70
7. STEPHENVILLE DIST. HEATING	4	3	1,300	230	150
SUB-TOTAL, WOODFUEL	82	54	8,910	1,500	910

RECOMMENDED PROJECTS BY THE PROVINCE - CONTINUED -

PEAT & REFUSE PLANTS 1988	000T/YR BIOMASS	PERM JOBS	TOTAL COST $000	FUEL SAVINGS/YR $000 $28 US/BBL	FUEL SAVINGS/YR $000 $20 US/BBL
8. MARYSTOWN SHIPYARD, PEAT BOILER	2	2	1,400 A.	100	70
9. ST. JOHN'S, ENERGY FROM WASTE	90	15	28,000 B.	3,800 C.	3,000 C.
SUB-TOTAL, PEAT & REFUSE	92	17	29,400	3,900	3,070
TOTAL, WOOD, PEAT & REFUSE	**174**	**71**	**38,310**	**5,400**	**3,980**

NOTES: A. PEAT SUPPLY INFRASTRUCTURE INCLUDED
B. 50% OF PLANT COST BY OTHERS
C. INCLUDES REVENUE FROM MUN HEATING AND ELECTRICITY SALES

BIOMASS FUELS PROJECTS SHOWN IN TABLES 1, 2, & 3

	000T/YR BIOMASS	PERM JOBS	TOTAL COST $000	FUEL SAVINGS/YR $000 $28 US/BBL	FUEL SAVINGS/YR $000 $20 US/BBL
GRAND TOTAL	**628**	**300**	**84,225**	**21,700**	**12,480**

Woodchip Conversion

Project Report

Newfoundland Hardwoods Limited and
Clarenville District Vocational School
Clarenville, Newfoundland

for the

Wood and Peat Energy Conference

November 18, 1986

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WOODCHIP CONVERSION - NEWFOUNDLAND HARDWOODS CLARENVILLE PLANT AND CLARENVILLE DISTRICT VOCATIONAL SCHOOL

A - NEWFOUNDLAND HARDWOODS CLARENVILLE PLANT

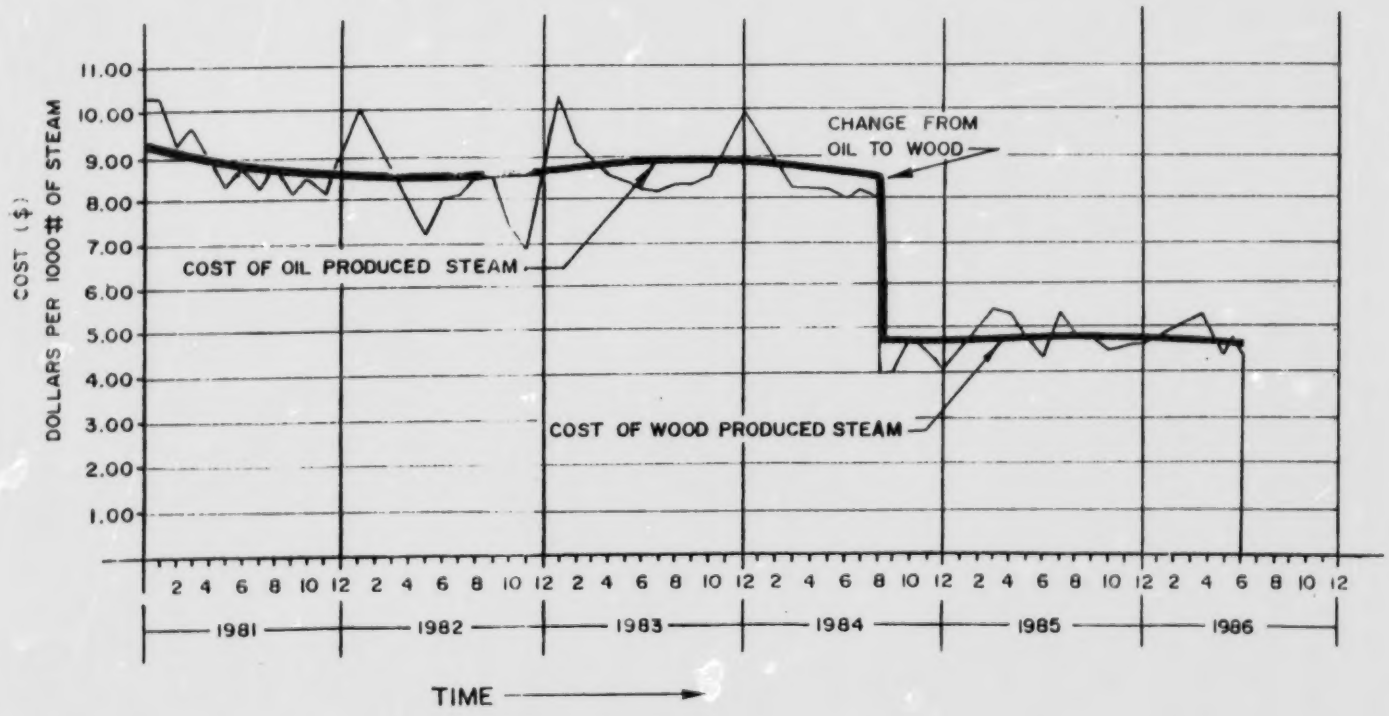
The Newfoundland Hardwoods operation in Clarenville was established in early 1936 to produce asphalt emulsion for paving the runways at Torbay, Gander, Argentia, and Stephenville and as a source of asphalt paving for roads. In 1948, a pressure treating process for the poles and timber was installed. Both the asphalt plant and the treating plant required large amounts of steam for the operation.

Steam for both operations was produced from an Erie City boiler initially burning coal but later converted to bunker "C" oil.

Due to the rapidly increasing cost of oil in the early 1980's, the management of the Newfoundland Hardwoods undertook a program to reduce the oil consumption of the boiler. First the asphalt storage tanks were insulated which gave a considerable savings, then ways were looked at to reduce further the cost of steam production which used approximately (250,000 - 300,000 gal) 1,136,500 - 136,400 L of bunker "C" depending on production requirements in any particular year.

Under a study funded by the Department of Mines and Energy, the feasibility of converting the Erie City boiler to wood fuel or installing a new wood burning unit was carried out. This study showed that a savings in fuel in the order of 40% could be achieved if a new boiler burning green whole tree chips were installed.

The design of the new boiler system and tender call were carried out in 1983 with the project completed in September 1984. The operation consisted of a fuel dump station, chip screen, fuel



NEWFOUNDLAND HARDWOODS ASPHALT & CREOSOTING DIVISION
CLARENVILLE, NEWFOUNDLAND
COST OF STEAM PRODUCTION OIL VS. WOOD

storage and a new (300 HP) 2940 kw completely automatic Bell boiler capable of producing (10,000 lb/hr) 454 kg/hr of steam by burning whole tree chips with a moisture content of 45%. The total project cost including engineering was $587,500 with annual savings of $120,000. Funding for the project was shared as follows. Newfoundland Hardwoods Limited $325,000, Federal Government $162,500, and the Provincial Government $100,000. The project had a simple payback of 4.9 years. A public tender was called for the fuel supply of approximately 5000 t per year and the contract awarded to Island Enterprises. It is of importance to note that this contract put in excess of $160,000 back in the local economy and has created three permanent jobs whereas the use of oil had a minimal local effect.

The new system has been in operation since September 1984 and no major problems have been encountered. As the plant was equipped with steam flow measuring devices, a large truck scale for weighing the wood chips and laboratory facilities to determine on a daily basis the moisture content of the wood, it was considered an ideal location to do monitoring on a wood burning unit. Again, the Department of Mines and Energy funded a program which has monitored, on a daily basis, fuel use, steam production and moisture content of fuel.

From this program, some valuable data has been obtained and by reviewing daily oil use and steam production records from 1981 to the start of the wood-fired unit, we have been able to obtain accurate cost comparisons of oil vs. wood. From start up in September 1983 to the end of 1985, savings of $245,000 were realized on oil which is approximately 8% greater than originally forecast. The cost of producing steam has been reduced from ($9.00/1000 lbs to $4.75/1000 lbs) $9.00/45.4 kg to 4.75/45.4 kg.

B - CLARENVILLE DISTRICT VOCATIONAL SCHOOL

With the Newfoundland Hardwoods plant in operation and a fuel supplier now established in the area, the Department of Mines and Energy wanted to demonstrate that a smaller wood burning unit would be feasible. To do this, the DVS in Clarenville was selected. In combination with the Department of Public Works, a system was designed for the DVS in Clarenville where the boiler, controls and fuel storage were completely enclosed in a portable building with the fuel dump station as a separate add-on package. The new unit was tied in to the existing boiler which would automatically cut in if needed for capacity.

This unit could be completely shop fabricated and tested and would only require connection to the heating mains and electrical supply at the site. In the design of the boiler, which was to be low pressure hot water, the daily use and peak loads were taken into consideration. The unit was then designed to operate at maximum efficiency by having the existing oil units cut in to meet the peak loads with the wood unit acting as a base load thus being able to work at high capacity for a larger portion of time.

Because of space constraints in the boiler room, a rotary screw was installed to act as a screening devise, this has worked with no problems and has eliminated the normal maintenance problems associated with screens. The total package cost for this work was $207,000 funded as follows. 45% by Department of Public Works, 35% by CREDA, and 20% by Department of Mines and Energy.

Due to a delivery in late 1985 and plant shut down during the NAPE strike, we have been unable to get accurate cost savings. However, a review of the information available to date indicates a savings over oil in the range of 40%. Monitoring will continue over the 1986/1987 year and a further analysis will be carried out in June of 1987.

A review of the two projects in both operational problems and financial considerations shows the following:

Design Considerations and Operational Constraints

- The staff should be trained in the operation of a wood system. A working visit to an operating plant would be desirable for all staff with a 1 week stay for the chief operator.

- There is some increased maintenance on the unit especially the fuel handling equipment. Allowance will have to be made for this on any financial analysis.

- An adequate ash handling system must be provided. The storage of the ash must be carefully designed to prevent any possibility of fire from the hot material.

- The plant should be designed to carry approximately 75% of the mean winter load. This will give you a unit that is operating near its maximum efficiency most of the time. The peak loads which are usually of very short duration can be met by having the existing oil unit come on in conjunction with the wood unit. The wood unit should not be designed so as it will have to operate at a load of less than 25-30% capacity.

- The systems should be designed to accept fuel with some oversize wood. Due to capital cost considerations and maintenance problems, screening should be avoided if at all possible. The fuel storage for the plant should be designed to allow for long weekends, storms in the winter and problems with the fuel supplier. In this case, it is normal to have enough fuel storage on site to provide three days under full load. Whole tree chips at 45% moisture will

weigh about (18 lb/ft^3) 288 kg/m^3 one cord of wood (3.62 m^3) will give approximately (4000 lbs) 1800 kg of chips and require (220 ft^3) 6.3 m^3 for storage.

- For small systems, the operator should give careful considerations to the method of delivery and storage of the wood fuel. If the chips are to be stored for any length of time, proper ventilation must be provided and steps taken to prevent spontaneous combustion of the fuel. If the area is to be kept clean and tidy, the mouth of the receiving bin must be built to prevent wind blowing of the material.

  If the operator is providing his own fuel, this is not a major problem, however, if it is supplied on a contract basis, the cut off point and the responsibility of the owner/supplier should be clear and who is responsible for clean up, etc. established at the time of contract award.

- As the capital cost of an installation is usually the determining factor in the decision to proceed, it is important to keep this to a minimum. Every effort should be made to utilize existing buildings or space for both the burning unit and for fuel storage with the provision of new buildings used as a last resort.

- The system design should always consider the owner requirements, staff available for operation, nature of business, type of heating/progress load, availability of fuel, etc. No two conversion are the same and each system must be studied to give the most cost effective installation.

- It is best to utilize off-the-shelf technology in both the burning unit and the fuel handling system. Replacement parts should be readily available from local sources.

- Local councils etc. may have some concern over air pollution. The wood fired units burn at a very high temperature and give practically no visible emission. Ninety-five percent of the fly ash is removed by a cyclone separator and presents no environmental problem.

C - FINANCE

- From the Clarenville operations, a payback of 4 - 6 years can be expected on capital investment. The greater the oil consumption, the shorter the payback.

- The Newfoundland Hardwoods (300 HP) 2940 kW unit cost $200 per KW installed.

- The DVS (30 HP) 294 kW unit cost $704 per kW installed.

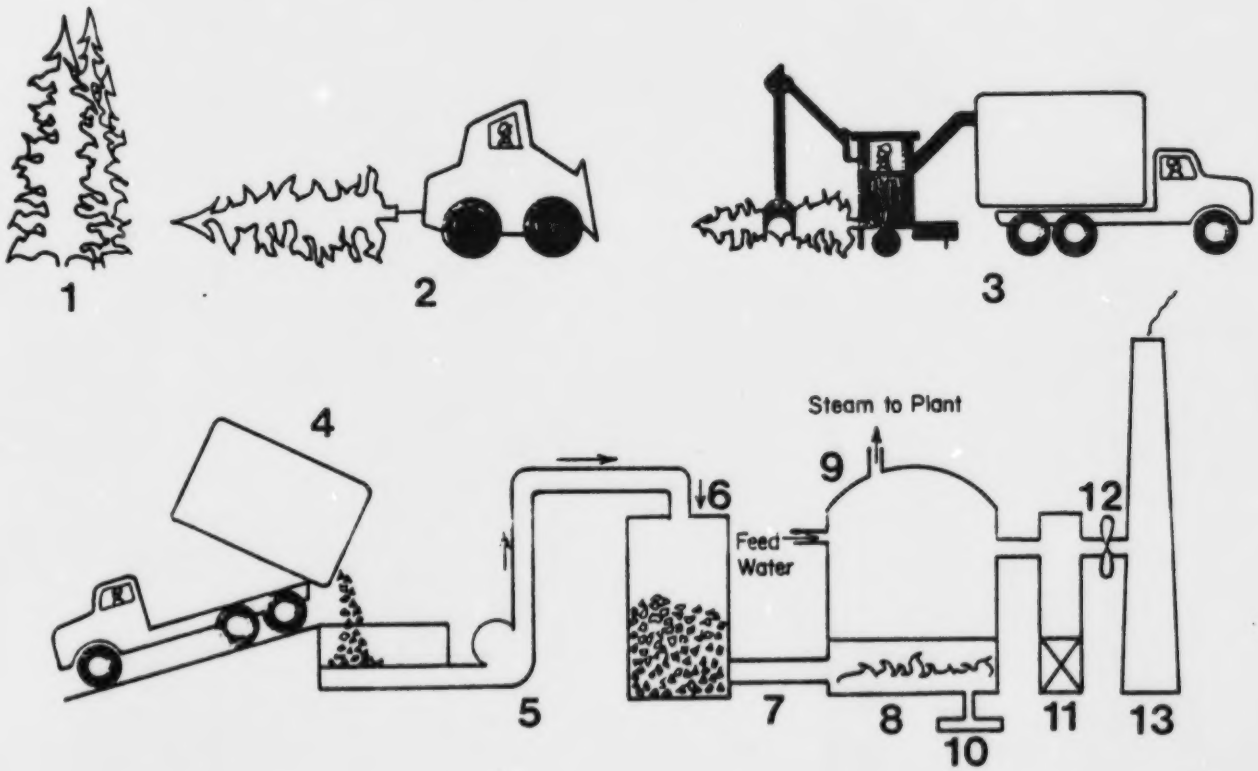
- The total oil consumption and fuel availability in the area is of prime importance in the decision to install a wood burning unit. A small unit cannot support a full scale chipping operation, however, sawmill waste is a very acceptable alternate and should be considered in all cases.

- The price of oil has an effect on the payback period and at present with the unstable oil situations, each project would have to be checked to see how sensitive the payback is to oil price changes. For most installation the savings are such that unless major decreases in oil occurs, the projects are not effected to the point of not being viable.

In conclusion, I would suggest that if any operation is now burning oil to produce steam or hot water for process or heating requirements and there is in the area, a source of wood/or wood waste available for use as fuel that serious consideration be given in looking into the possibility of converting from oil to

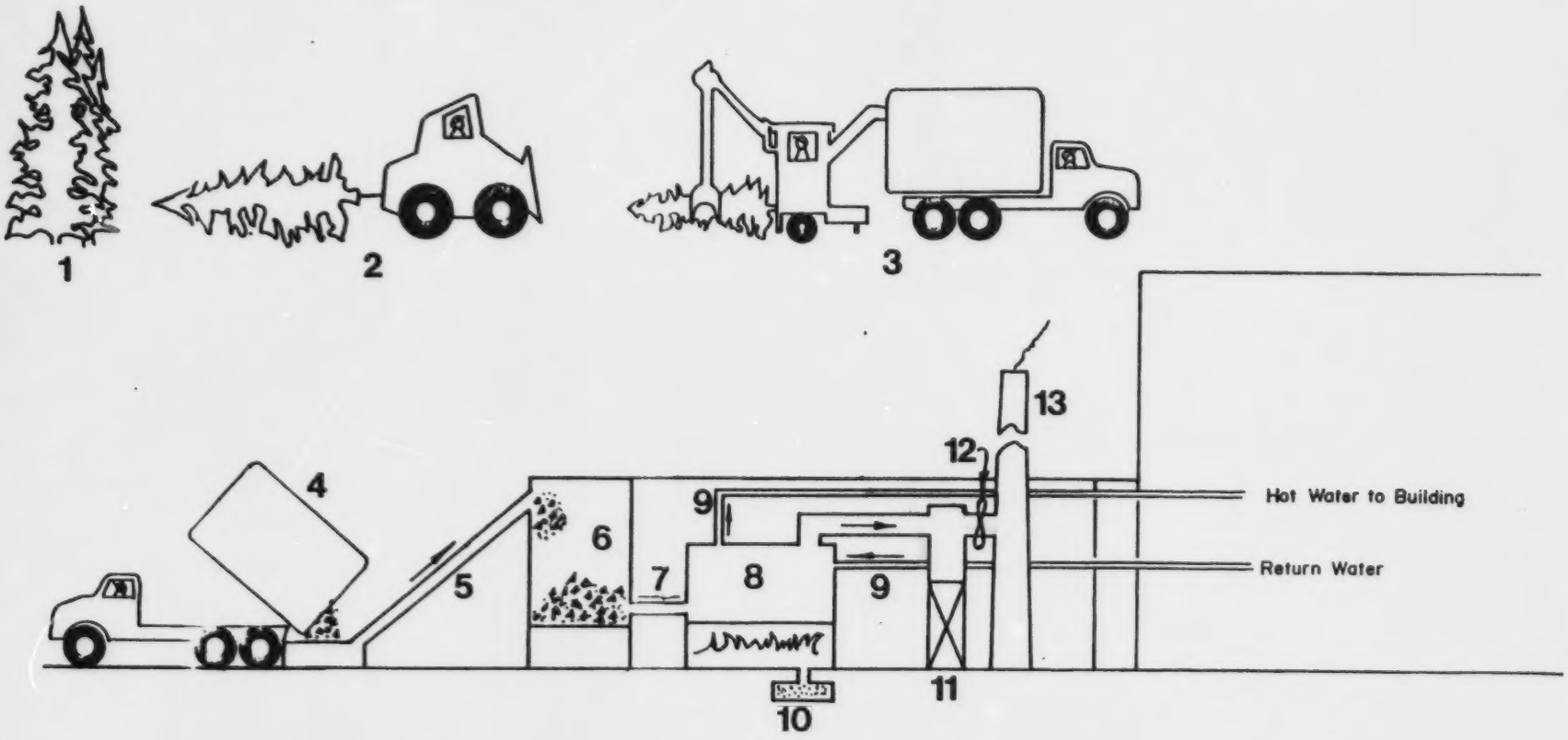
wood as savings in the order of 30 - 50% can be realized on present fuel costs.

MATERIAL FLOW DIAGRAM FOR NEWFOUNDLAND HARDWOODS, CLARENVILLE:



1) Uncommercial Timber
2) Felled by chainsaw and skidded to roadside
3) Roadside Chipping
4) Chips delivered to Newfoundland Hardwoods
5) Chips screened and blown into silo
6) Four-day storage
7) Fuel feed to burner
8) Wood boiler (10,000 lbs. steam per hour, 150 psi)
9) Water infeed, steam out to plant
10) Ash Removal
11) Grit Arrester
12) Induced drift fan
13) Stack.

MATERIAL FLOW DIAGRAM FOR CLARENVILLE DISTRICT VOCATIONAL SCHOOL



1) Uncommercial timber
2) Felled by chainsaw and skidded to roadside
3) Roadside chipping
4) Chips delivered to Clarenville DVS
5) Chips conveyed into silo
6) Chip storage
7) Fuel feed to burner
8) Wood boiler (30 bhp)
9) Water infeed, hot water out to building
10) Ash removal
11) Grit arrester
12) Induced drift fan
13) Stack

Wood-Fired Boiler Project

James Paton Memorial Hospital
Gander, Newfoundland

for the

Wood and Peat Energy Conference

November 18, 1986

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INTRODUCTION

A wood-fired boiler system was installed at the James Paton Memorial Hospital in Gander to replace the existing oil fired operation. The purpose of this report is to provide an overview of the project outlining the objectives, the difficulties and the results achieved. With this information, conclusions relating to the project's feasibility can be drawn and by inference the potential for other wood-fuel systems in Newfoundland.

PROJECT HISTORY

Project Background

The Newfoundland Department of Forest Resources and Lands (FRL) initially proposed the conversion from oil heating to wood for the James Paton Memorial Hospital (JPMH) in Gander. The FRL proposal was considered by Newfoundland Mines and Energy (ME) and Energy, Mines and Resources Canada (EMR), and approved for 75% funding under the Canada/Newfoundland Conservation and Renewable Energy Demonstration Agreement (CREDA). The Gander and District Hospital Board of Directors agreed to co-operate with the project subject to two conditions. First, all funding would be arranged by the Federal and Provincial Governments, and secondly, an environmental impact study focusing on air and noise pollution would be conducted and implemented.

The project was approved on the basis of the potential benefits offered by a wood-fuel conversion. As an individual installation, the proposed project provided sound economic justification. Wood waste, at a predicted cost of $20.00 per green tonne, was only one half the then current cost of oil. A potential annual fuel saving of $90,000 was anticipated for the Hospital. A survey of local sawmills (within a 55 kilometre radius of Gander) confirmed an abundant supply of wood waste to satisfy the Hospital's requirement of 4,000 green tonnes per year.

PROJECT HISTORY (Cont'd)

Project Background (Cont'd)

The objectives of this project, however, went far beyond the financial benefits of one installation. The project was a prototype in Newfoundland. It was intended as a first step toward the ultimate goal of a province-wide wood fuel industry using wood waste and whole-tree chips to heat industrial and commercial buildings. The benefits of such an industry would be manifold. Over 200 new jobs would be created in supplying wood fuel to a stable, year-round market. In addition, forest management and silviculture would benefit from the cleaning up of unproductive forests.

Initially, the project budget was estimated at $450,000 and the proposed funding arrangement between CREDA, FRL, Department of Health and the Gander and District Hospital Board was as follows:

-	CREDA	$337,500	75%
-	Department of Health and Gander Hospital	$ 92,500	20%
-	FRL*	$ 20,000	5%
TOTAL:		$450,000	

* FRL's portion of funding did not include an additional $9,500 for an environmental study.

The budget was revised several times over the course of the project resulting in an overall increase in project cost to approximately $1 million, with the final cost sharing being:

-	CREDA	$ 856,000	85%
-	Health/Gander Hospital	$ 132,500	13%
-	FRL	$ 20,000	2%
TOTAL:		$ 1,008,500	

PROJECT HISTORY (Cont'd)

Existing System

The James Paton Memorial Hospital was constructed in 1964 having 11,900 sq.m. of heated space. The facility has a present capacity of 162 beds and offers full hospital services including in-house laundry. The site plan for the hospital can be seen on Figure 1.

Prior to the wood burning project, the hospital's total steam demand was supplied by two 250 horsepower, powermaster, oil-fired steam boilers located in the main boiler house. At maximum capacity each boiler was capable of producing 3900 kg steam/hour at 1035 kPa with a rated fuel consumption of 310 l/hr.

The required level of steam production varies hourly, daily and monthly. The hourly and daily fluctuations reflect the scheduled usage of domestic hot water and in-house laundry services. The steam used for heating purposes varies with requirements of the heating season.

WOOD CONVERSION PROJECT

General

Under the general approach adopted for this project, the project managers undertook the conceptual design and selection of major equipment components. The engineering consultant was then responsible for combining the components into a workable system design and for preparing tender documents. With this approach the project can be categorized into several distinct phases:

WOOD CONVERSION PROJECT (Cont'd)

General (Cont'd)

- initial planning and conceptual design
- equipment selection
- detailed system design
- contract tender and award
- construction
- operational adjustments

Initial Proposal

The Department of Forest Resources and Lands developed the initial proposal for this project which outlined the preliminary concepts and an estimated project cost of $450,000.

The basic concepts taken from the original proposal are reproduced in Figure 2. A dome structure, used to stockpile wood fuel, would also house the truck unloading and silo loading equipment. The wood fuel would be conveyed, first to the silo, then to the metering hopper, and finally to the burner. The proposed boiler-burner system would be installed in the existing boiler house. As the project evolved, however, the initial concepts were revised significantly. The details of these changes are presented in the following sections.

Conceptual Design

The project management committee developed the proposal concepts into a more detailed conceptual design. The conceptual changes evolved from the initial proposal in response to several factors; new requirements resulting from the selection of alternate equipment, unforeseen problems emerging from more detailed study, and finally, efforts to reduce the capital cost. The major conceptual revisions are described further.

WOOD CONVERSION PROJECT (Cont'd)

Conceptual Design (Cont'd)

An alternate boiler-burner unit was selected which could not be accommodated in the existing boiler house as originally proposed. Although the selected system was suitable for outdoor installation, this concept was rejected because of the increased long-term maintenance costs and unfavourable working conditions in the ongoing operation. Thus the concept was revised to include a new boiler house for the new system.

Also, the winter storage dome was deleted since the required fire protection system was much more extensive, and therefore more costly, than originally anticipated. Although the dome was eliminated to reduce the capital cost of the project, the deletion necessitated other modifications, which reduced the net realizable cost savings.

The truck unloading equipment, initially housed in the dome, required an additional new building enclosure. Also, an off-site storage area to provide winter storage of waste wood was added to the project to replace the storage capacity initially provided by the dome.

In addition, the concept was revised to include a larger silo. Sufficient wood-chip capacity for three days of normal winter operation was required rather than the one day storage capacity acceptable with the dome concept. The silo would be located inside the new boiler house to eliminate the need for insulation and steam tracing which are normally installed on an outdoor silo to prevent the wood fuel from freezing.

WOOD CONVERSION PROJECT (Cont'd)

Conceptual Design (Cont'd)

The last major conceptual change involved the silo unloader system. Upon the manufacturer's recommendation, the "metering bin" concept was revised to a 'live bottom' silo arrangement with a variable speed screw conveyor providing the fuel metering. This new system is further described in the following section.

Equipment Selection

The major equipment components selected and purchased by the project management committee comprised:

- boiler-burner unit
- silo and silo unloading system
- truck unloading and silo loading system

System Design

ShawMont Newfoundland Limited was selected as the engineering consultant to complete the final detailed design of the system.

Difficulties were experienced during the design phase which delayed the project completion. The project was a 'first of its kind' in Newfoundland and the consultant's unfamiliarity necessitated additional time and effort in developing the detailed design. Two other factors caused considerable delays during the design phase; the lack of supplier information, and ongoing conceptual changes.

Lamb-Cargate was very slow in providing detailed and accurate design information for the boiler-burner equipment. Several underlying factors may have contributed to the delays in transferring information. The unit was a 'special design' because

WOOD CONVERSION PROJECT (Cont'd)

System Design (Cont'd)

of its small size and Lamb-Cargate had to develop the design and information documentation. Also, Lamb-Cargate normally supplied and installed their units. Thus the supplier was reluctant to release what they considered "proprietory" installation information. In addition to delaying the design, the lack of accurate information caused problems during construction.

The final design was also hindered by ongoing changes in the conceptual design. Many of the conceptual changes described previously were made after the final design was underway. With each change, ShawMont was required to redesign or modify the affected portion of the project.

Construction

The construction phase of the Woodburning Project began in November of 1981 and continued through to March, 1983. (The building housing the truck unloading system was constructed later by the Hospital's own forces.) Concept changes, design delays, winter weather, and equipment defects all contributed to the lengthy construction period.

Operational Adjustments

The system commissioning was accomplished with no more than a normal amount of start-up and debugging problems. After the system was put into operation, the Hospital corrected other problems as they arose, and in general, fine-tuned the system. As a result, the system's current operation is smooth, efficient and relatively trouble free.

WOOD CONVERSION PROJECT (Cont'd)

Observations

The extra work associated with the wood burning system are supervising the truck unloading operation, removing the ashes and performing general maintenance. This work is contracted to the chip supplier at a cost of $600/month.

The system entails a greater electrical consumption which amounts top an estimated additional cost of $16,000 per year. The actual usage is difficult to verify, since the entire hospital is served by one meter. The additional annual maintenance costs over the first two years of operation were estimated to be $12,000 per year. This cost increase seems reasonable since the wood system is much more complex with numerous moving parts such as arms, hydraulic runs, screw conveyors and augers.

Economic Analysis

The following input parameters were applied to the economic model in order to determine project feasibility.

Annual Fuel Cost Savings	$ 106,470
Oil Cost Escalation	6%
Wood Cost Escalation	4%
Annual Operation & Maintenance	$ 31,200
Operation & Maintenance Escalation	4%
Project Life	20 Years
Discount Rate	13%
Capital Cost	$1,008,500
Salvage Value	-

Economic Analysis (Cont'd)

The following results were calculated from the program:

Net Present Value	$42,468
Return on Investment	13.95
Internal Rate of Return	12.50
Benefit Cost Ratio	1.04
True Payback Period	18.82
Simple Payback Period	13.4

The economic indicators showed that the project is economically viable although the simple payback is poor. With the drop in world oil prices, the projected economics are not being realized although they should fall back in line over the life of the system.

Conclusions and Recommendations

The wood fuel system installation at the Gander Hospital was successful in achieving the project's objectives. After two years of operation, the system has proven itself as a reliable source of low cost steam. The system has achieved the projected operating cost reductions, and despite the substantially higher-than-anticipated capital cost, the project is still economically viable. The project's greatest accomplishment, however, was the invaluable learning experience later applied in subsequent wood fuel conversion projects.

An approach well proven since this initial Tender Project is a "turn key" system from suppliers. A general specification of system requirements is prepared and equipment suppliers are asked to bid on a supply and erect package. Only one, or at the most two suppliers are required for the entire project. The engineering consultants assume primarily, management function, and a lesser design function for the civil work, and the integration of the purchased system into the existing plant's mechanical and electrical system. No time or money is lost on the unproven integration of different supplier's equipment.

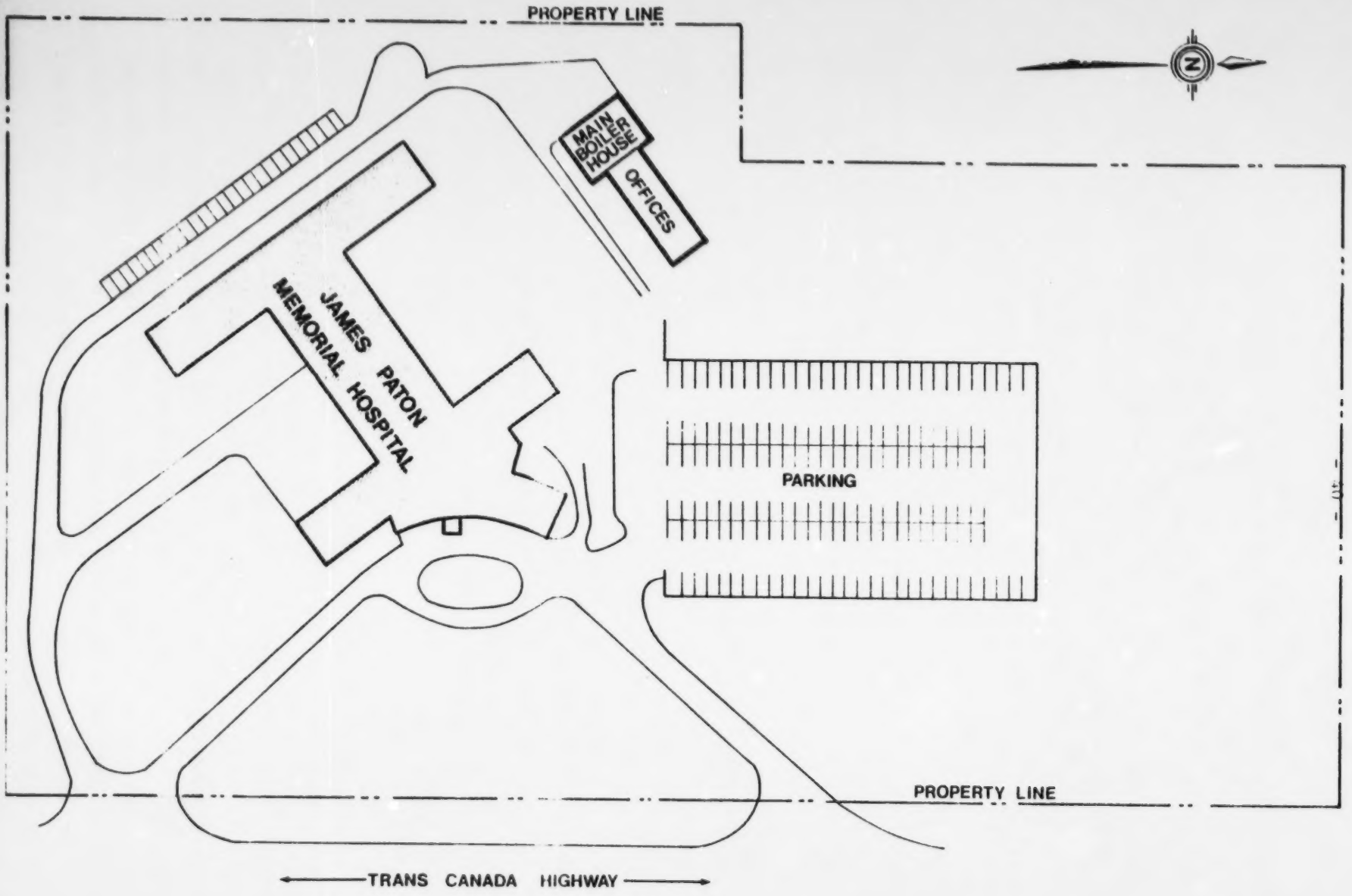
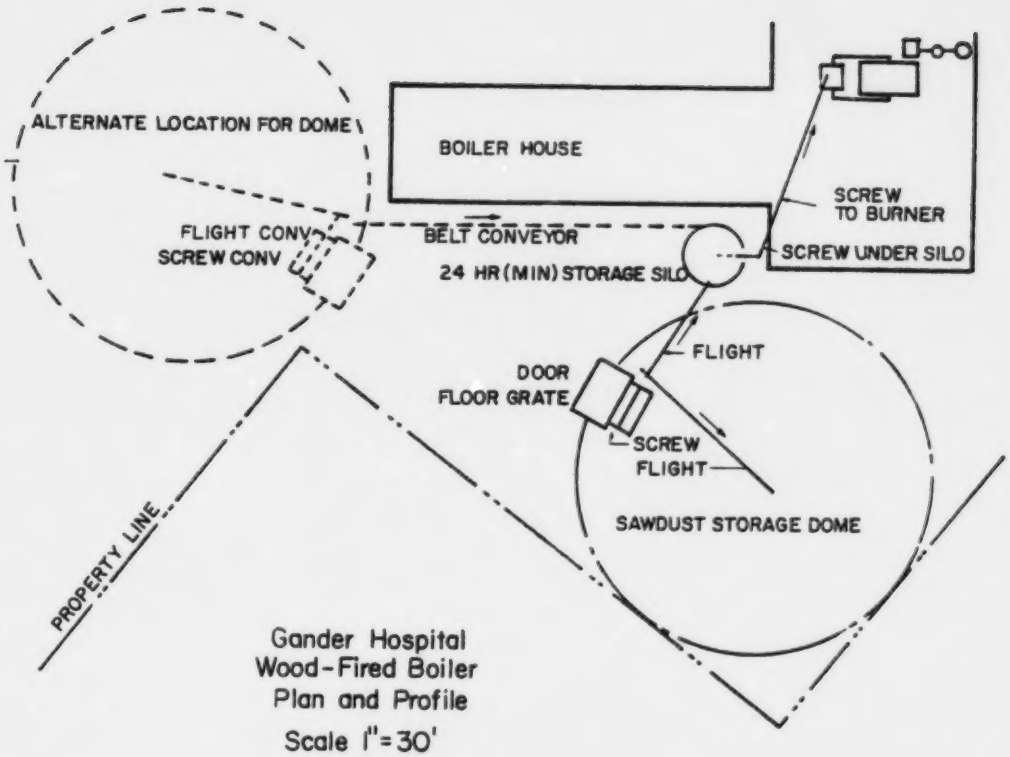
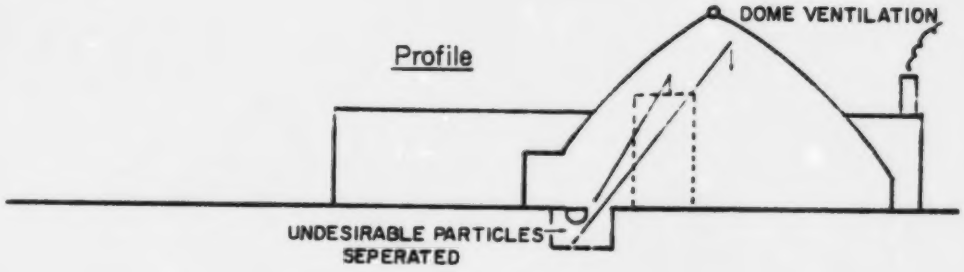


FIGURE 1

EXISTING SITE PLAN



Gander Hospital
Wood-Fired Boiler
Plan and Profile
Scale 1"=30'



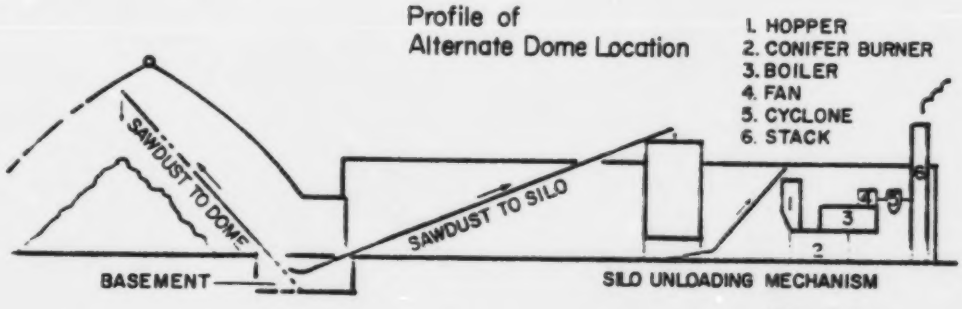


FIG. 3.2

FIGURE 2

CONCEPTUAL SCHEMATIC FROM PROPOSAL

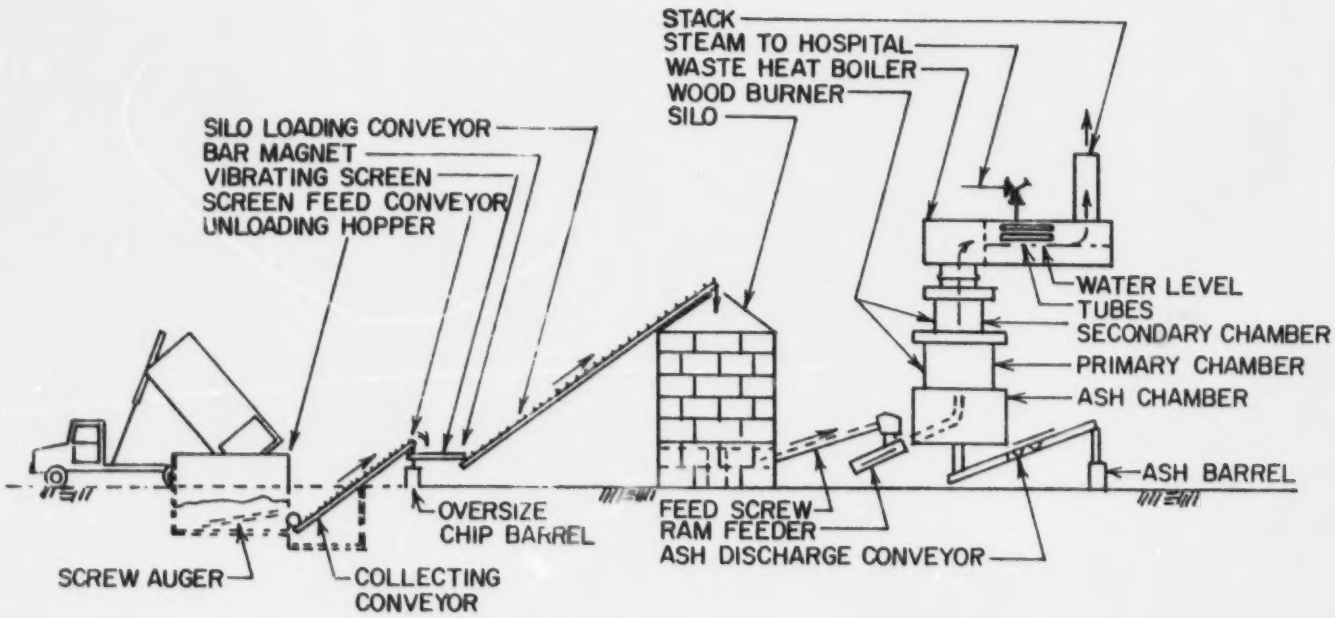


FIGURE 3

SYSTEM OPERATION SCHEMATIC

Wood-Fired Boiler Feasibility Study

Western Memorial Regional Hospital
Corner Brook, Newfoundland

for the

Wood and Peat Energy Conference

November 18, 1986

Study Presented By:

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INTRODUCTION

The Western Memorial Regional Hospital initiated this feasibility study as a preliminary step in assessing the possible implications of installing a wood fired heating system at the hospital. The purpose of this report is to investigate the economic feasibility of converting to a wood fuel energy source, and to develop a preliminary design of a wood fired heating system based on system information proposed by equipment manufacturers.

The scope of this study includes: A site inspection at the hospital to determine the physical and operating limitations of a wood burning system; A review of the current energy requirements; Specification of a wood handling and burning system to be located at the existing plant and preliminary design of the electrical and mechanical tie-ins and associated civil work; Preparation of information package so that equipment suppliers may propose mechanical systems that meet the specifications and include budget quotations; An economic analysis on the conversion to wood heat considering: capital cost, fuel cost and operation and maintenance cost (including labour).

DESCRIPTION

Western Memorial Hospital commenced operation in 1950 and has expanded considerably to a large present day complex. The major source of energy for the facility is 860 kPa steam produced by two 12.8 MW watertube boilers burning bunker "C" fuel oil. The second boiler is for full back-up capacity which is a requirement at all hospitals.

The average annual oil fuel consumption after the most recent energy conservation retrofit at the hospital is 2.3 million litres of oil. The present day cost is $0.23 per litre amounting to an annual cost of $530,000. This consumption includes 180,000 litres to operate the air conditioning in the summer months and approximately 55,000 litres to maintain one boiler on standby.

STEAM REQUIREMENTS

The hospital provided a wealth of historical operating data which was analyzed to project the daily and weekly steam requirements. The steam production charts fluctuate constantly, however, pattern similarities were noted and typical loading profiles were developed for week days and week-ends. The peak load at the hospital was found to be 7.3 MW, however, this seldom occurs.

A cross-section of typical wood fired boiler sizes was selected and calculations were made for each size to determine what portion of the hospitals total steam requirement could be met. Table 1 outlines these displacement percentages for 1983 weather conditions and for a typical year. Neither of these include the effects of the 1984 energy retrofits. For an average year, a 6.0 MW boiler would meet 99.95% the total of requirements and a 3.6 MW boiler would meet 91.9% of these requirements.

The average peaks were then adjusted to reflect the projected energy consumption after the 1984 hospital system renovations. With the projected reduction in energy usage, smaller system capacities would achieve the same displacement penetration. This correlation of system capacity versus displacement potential is presented graphically in Figure 1.

This is a very significant analysis in that it demonstrates the fact that a wood boiler much smaller than the existing oil fired unit can be installed and replace most of the high cost oil with lower cost wood fuel. In this manner, the capital cost and space requirements of the new system can be minimized.

WOOD SYSTEM EFFICIENCY OPTIMIZATION

The economic justification of installing a wood-fuel heating system is derived from the reduced operating costs made possible

WOOD SYSTEM EFFICIENCY OPTIMIZATION (Cont'd)

by utilizing a lower cost source of fuel. The energy costs associated with the existing oil-fired operation can be accurately estimated since current oil prices are known and the system efficiencies can be determined from historical information. The energy cost savings derived from a wood fuel system depend on a number of factors: the cost of wood fuel, the heat content of the wood fuel, the quantity of oil displaced by wood fuel, and the overall operating efficiency of the installed system. The displaced oil quantity and the system efficiency, are largely a function of the selected system capacity.

There are two basic approaches that may be taken in selecting and sizing a wood-fuel heating system. The first method is to select a system with sufficient capacity to meet the highest anticipated load requirement. With this 'peak load' approach, the wood-boiler would meet 100% of the required steam production and replace 100% of the oil available for displacement. By sizing to meet the peak, however, the system would operate well below full capacity throughout most of the year. This reduced loading factor leads to lower overall operating efficiencies.

The second approach is to deliberately undersize the wood fired system. With this approach the wood system could not meet the peak load conditions, thus requiring an auxiliary system to make up the capacity deficiencies that occur during peak requirement periods. A portion of the potential oil displacement would be lost using the undersizing approach. There is one advantage with this second method, however, that often overrides the disadvantage already mentioned. The average capacity utilization of a smaller system is much higher and thus leads to a higher overall operating efficiency.

WOOD SYSTEM EFFICIENCY OPTIMIZATION (Cont'd)

The wood system manufacturers take the average winter consumption and size their system so it meets this amount at 75% capacity. At Western Memorial Hospital this worked out to be 3.6 MW. Interesting that this is, almost exactly half of the peak load which is another method for sizing an optimal size system. These wood systems will generally output 10 to 15% more than the rated output.

At Western Memorial, a 3.6 MW system will pick up 98% of the annual heating fuel requirement after the most recent energy conservation retrofits.

PRELIMINARY DESIGN

A large part of wood fuel systems is equipment to store and handle the bulky fuel. Generally, in the Industry, storage systems are designed for three days capacity in January. At Western Memorial Hospital, this amounted to 110 tonnes (300 M^3) storage capacity. The silo to the boiler handling equipment must convey 2 tonnes of chips per hour.

The methodology for dumping the chips into the silo must minimize the turnaround time for the delivery trucks and not require labour intensive procedures requiring an operator. The simplest method of approaching this is to dump down into an underground storage system as opposed to conveying it up into a storage tank style system. The underground system was our preferred silo, however, it was left to the suppliers to provide options.

The conveyance from the silo to the boiler is all part of the standard package from different manufacturers and therefore it dictates their storage system.

PRELIMINARY DESIGN (Cont'd)

Most of the suppliers returned with underground storage systems whereby the chips are moved by hydraulic rams and then moved into the boiler room with an auger feed system.

Figure 2 is a typical layout that was returned to us from the manufacturers. To this point, it hasn't been fully determined which system will be chosen.

WOOD AVAILABILITY AND COST

Based on the experience of other wood fuel operations in Newfoundland, this report assumes that the source of fuel for this project will be wood chips produced from Newfoundland softwood. It is further assumed that the moisture content of the delivered wood fuel will not be greater than 45%. The moisture content is a significant factor in determining the heat content per tonne of wood and thus, the potential fuel savings. At 10% moisture content for example, a tonne of wood chips will produce 4867 kgs of steam (at 65% efficiency). At 45% moisture content a tonne of wood chips will produce only 2,704 kgs of steam under the same conditions. Wood at 45% moisture content, however, is the best compromise despite the improved characteristics offered by dry wood fuel. Wood at 40% to 45% M.C. is readily available and can be delivered directly. A lower moisture specification would entail an additional storage or drying process which would increase the cost of delivered fuel substantially.

For the purposes of this report, a projected wood-chip cost of $34/tonne is assumed. This assumption is in line with the price being paid for wood chips in other areas of Newfoundland. The

WOOD AVAILABILITY AND COST (Cont'd)

James Paton Memorial Hospital in Gander and the Newfoundland Hardwoods plant in Clarenville are two such facilities. This cost is high in comparison to the price being paid in other parts of Canada, and to the costs experienced by the pulp and paper mills in the province. As the future demand for wood chips expands in Newfoundland, the cost may be reduced because of economics of scale in the supply operations.

Wood availability should not prove to be a problem in the Corner Brook area since there is a considerable amount of timber available compared to the small amount required. Increased waste timber harvesting coupled with modern forestry management techniques should permit harvesting substantial wood fuel supplies without causing any negative impact in the region.

PROJECT STATUS

This project was held up by problems in obtaining cutting rights from Kruger for the guaranteed supply of wood fuel. The situation is expected to be solved in the near future and construction should commence in the summer of 1987.

ECONOMIC ANALYSIS

When this study was first done, the cost of bunker "C" heating oil was $0.30 per litre. With the drop in world oil prices, the present day cost is $0.23 per litre. This cost reduction has a big impact on the economic analysis and both cases are presented to show the economic viability of the project.

The following input parameters were applied to the economic model in order to determine project feasibility.

ECONOMIC ANALYSIS (Cont'd)

	1984	1986
Annual Fuel Cost Savings	$338,900	$185,680
Oil Cost Escalation	6%	6%
Wood Cost Escalation	4.3%	4.3%
Annual Operation & Maintenance	$45,000	$45,000
Operation & Maintenance Escalation	4.3%	4.3%
Project Life	20 years	20 years
Discount Rate	13%	10%
Capital Cost	$980,000	$1,050,000
Salvage Value	-	

The following results were calculated from the program:

	1984	1986
Net Present Value	$2,805,978	$1,380,020
Return on Investment	54.99%	27.18%
Internal Rate of Return	40.29%	21.51%
Benefit Cost Ratio	3.86	2.31
True Payback Period	3.70 years	7.91 years
Simple Payback Period	3.33 years	7.46 years

The economic indicators all show the proposed installation of a wood fired heating system at Western Memorial Hospital to be a highly feasible and attractive investment.

CONCLUSIONS AND RECOMMENDATIONS

The findings of this report indicate that the installation of a wood fired heating system at Western Memorial Hospital would be technically and financially feasible. The system could be installed without having any adverse effect on the existing operation or its reliability.

It is recommended that the base load system be installed as indicated in the preliminary design. It is also recommended that the installation be made under a single turn-key type arrangement with an equipment supplier.

This project will have substantial economic benefit to the Hospital as indicated in the Economic Analysis and it will create 6 full time jobs in the Corner Brook area.

TABLE 1

DISPLACEMENT POTENTIAL VS WOOD SYSTEM CAPACITY

1. Before 1984 energy retrofits work

Wood System Output Capacity (MW)	Displacement 1983 %	Potential Normal Year %
3.6	92.3	91.9
4.5	98.8	98.6
6.0	99.96	99.95

2. After 1984 energy retrofit work

Wood Output Capacity MW	Displacement Potential (%) (1)	Supplementary Heating Requirements (hrs/year) (2)
3.1	91.9	1165
4.0	98.6	333
5.5	99.95	9

NOTES:

(1) Percentage of total steam requirements that can be aprovided from wood fuel system at assumed output capacity. Estimated displacement assumes 30 year average climatic conditions and includes effect of 1984 energy retrofit work at full savings predictions.

(2) Projected hours of annual operation during which some form of supplementary heating would be required.

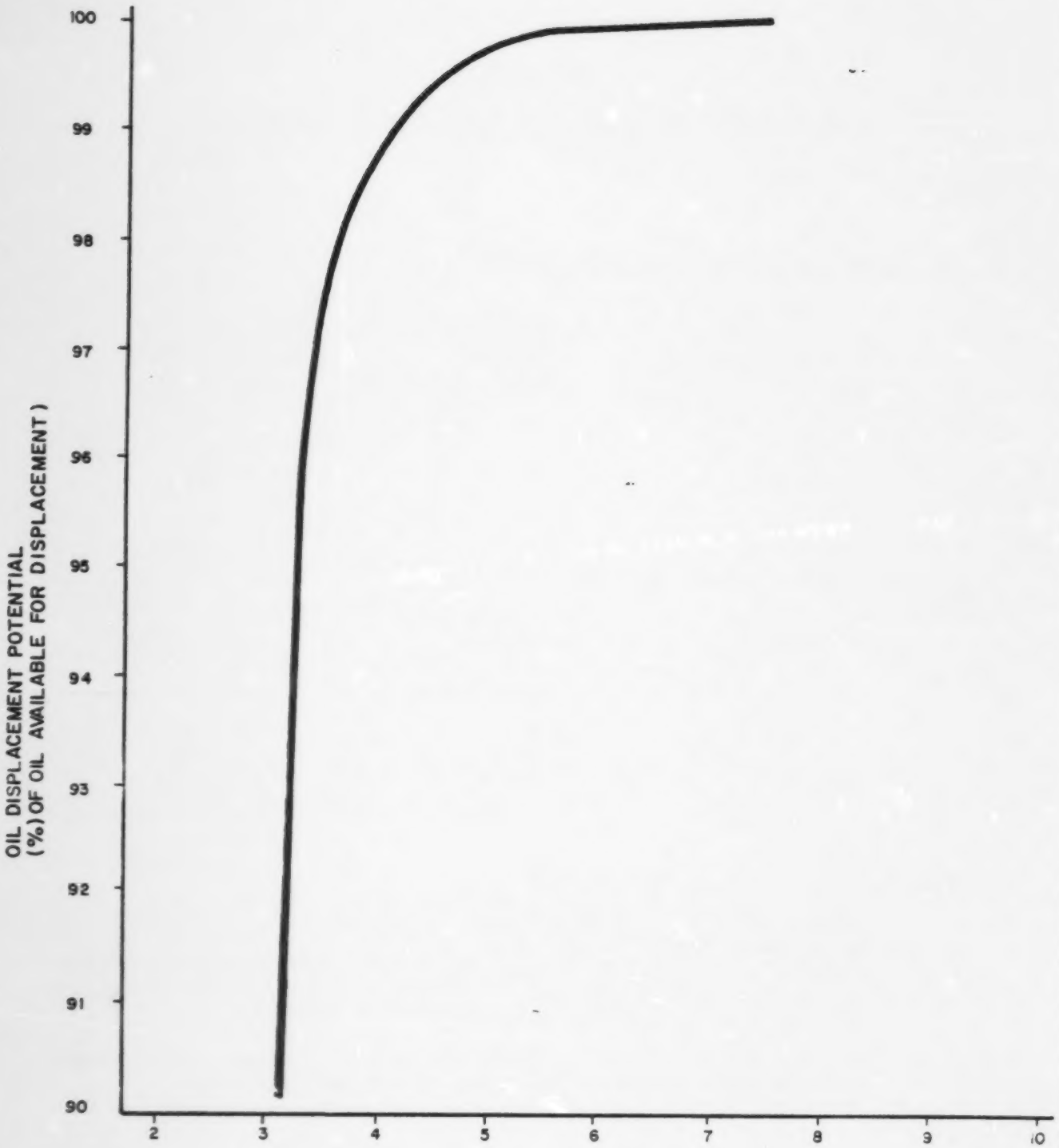
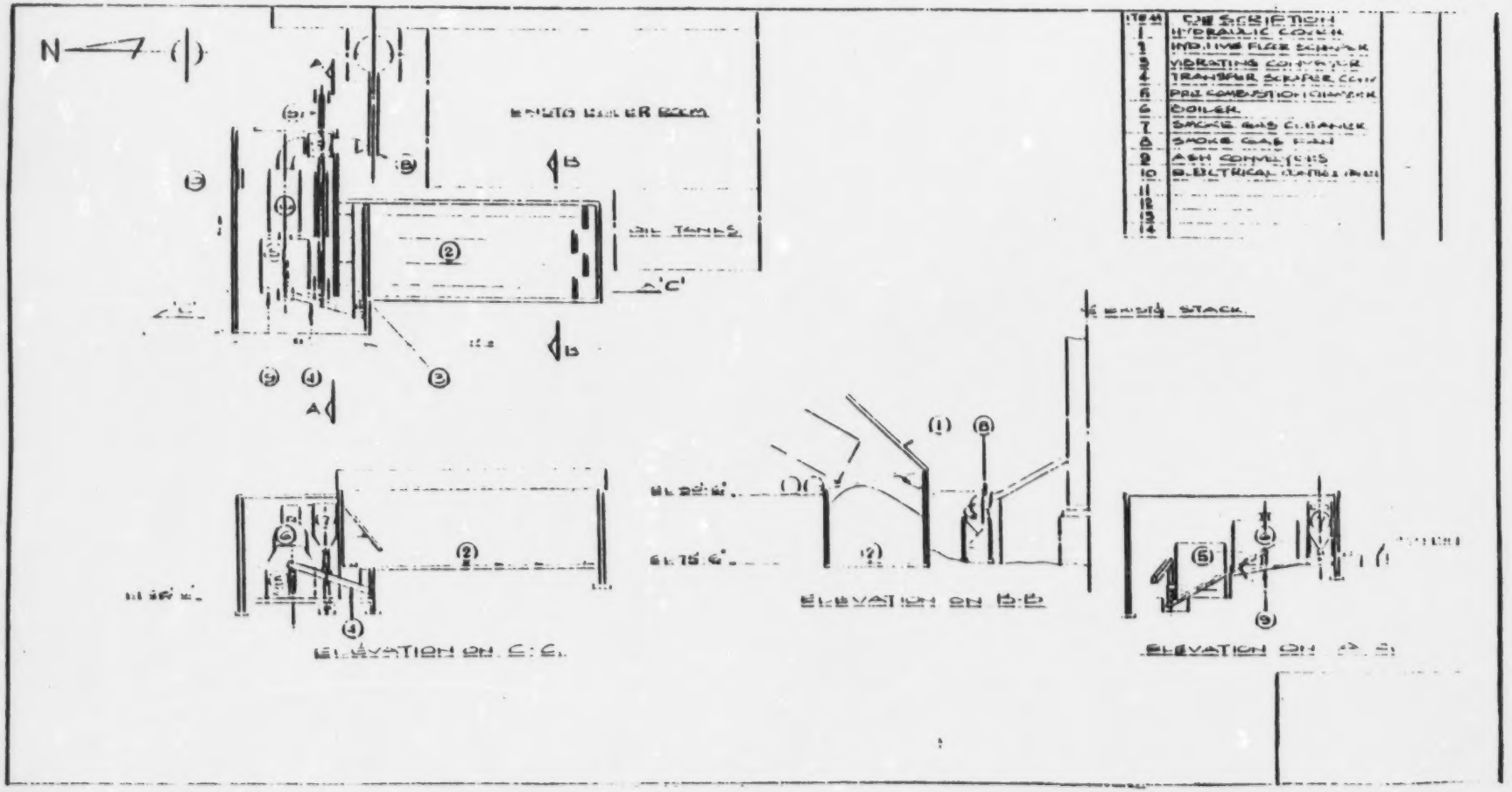


FIGURE 1

DISPLACEMENT POTENTIAL vs WOOD SYSTEM CAPACITY

FIGURE 2

EQUIPMENT SUPPLIER LAYOUT



Fuel Peat Demand and Boiler Conversion Feasibility Study

Energy Demand and Fuel Peat Conversion
Burin Peninsula

for the

Wood and Peat Energy Conference

November 18, 1986

Report Presented By:
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Energy Demand and Fuel Peat Conversion Study Burin Peninsula

Gerald Stapleton and Donald Finch,
Provincial Consultants Limited

ABSTRACT

This study examined (a) the potential fuel oil displacement of fuel peat on the Burin Peninsula, Nfld., Canada, and (b) the technical and financial viability of converting three facilities; a large fish processing plant, a medium size ship building plant and an elementary school to peat fired systems.

The results of the study indicate that there is an actual fuel oil displacement potential of 15.7 million litres of fuel oil or 61,600 tonnes of fuel peat out of a total possible supply of 23.5 million tonnes available within economic range of the major population centres. A complete life cycle analysis was carried out for all three facilities. Of the three facilities examined two of the three; the fishplant and the shipyard are economically viable while the school is marginally inviable.

INTRODUCTION

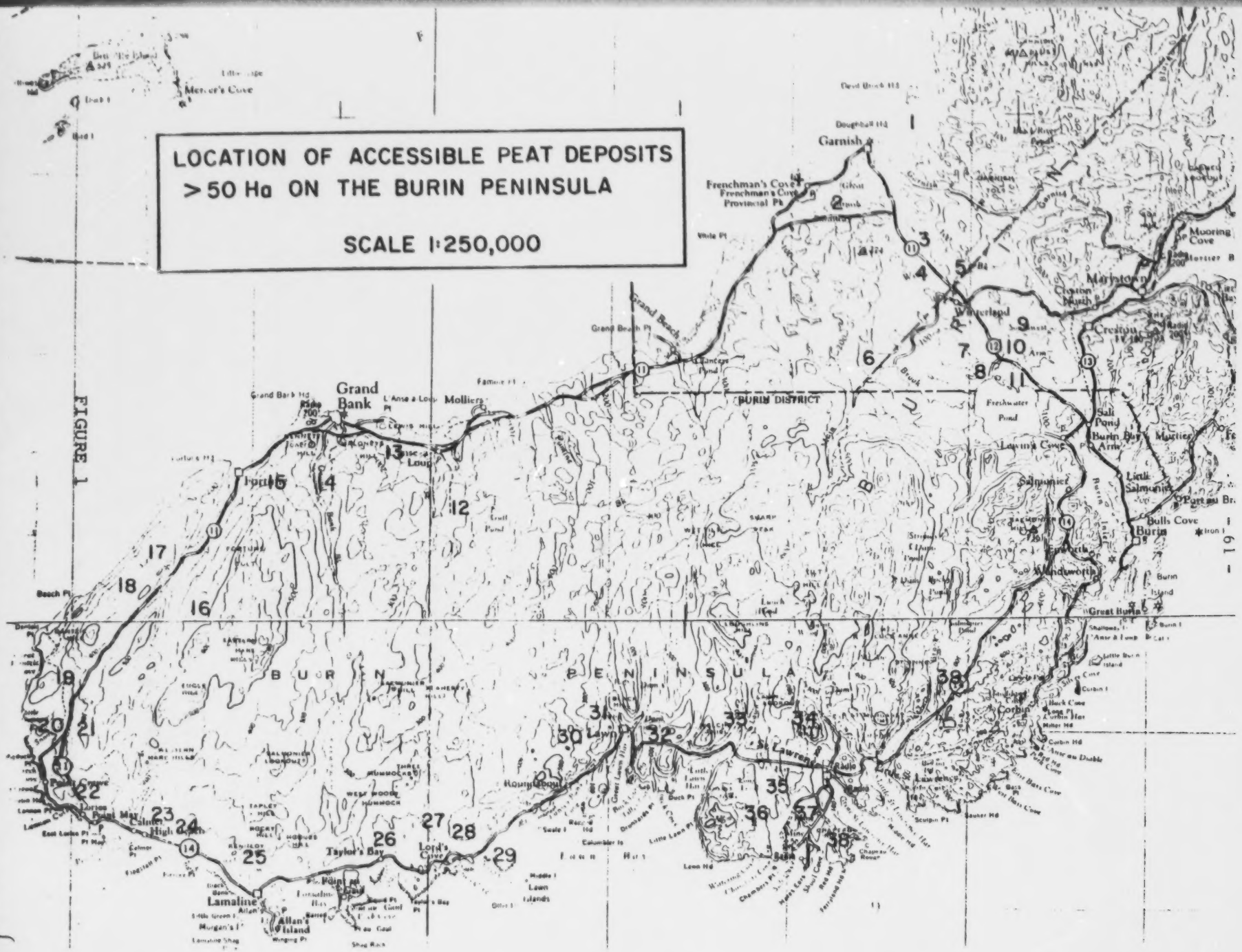
The findings of the study indicate that there is a large potential for the use of fuel peat in the Southern Burin Peninsula Area. With the proper approach, the viable conversion of existing heating plants to the use of this fuel will result. The capital cost for conversion can be justified by its amoritization over the life of the heating plant. The resulting benefit will be a net saving in annual operating costs.

PEAT SUPPLY

A review of the peatland inventory for the study area was completed. Accessible peatfields were identified during the inventory as being within one kilometer (km) of an existing road network and being at least 50 hectares (ha) in size. There are 39 peatfields that meet this criteria, for a total of 15,493 ha of peatland. Their locations are shown in Figure 1. The estimated volume of fuel peat for this indigenous fuel within the 39 peatfields is 147,673,100 cubic metres.

This fuel, before development of the peatfield (fuel peat in-situ), is 90 - 95% moisture, and after mining is about 50% moisture. The actual moisture content will be dependent upon the post-harvesting exposure to moisture (ie:precipitation), and the degree of drying during storage before combustion. The equivalent energy content of the 147,673,100 cubic metres in-situ is 6000 million litres (39 million barrels) of fuel oil #2 (furnace oil). An average moisture content of 93% for in-situ fuel peat is assumed for this conversion.

As there is no fuel peat production of significant volumes in the province the cost of mining the fuel had to be estimated. A preliminary production level of 9200 tonnes was projected to require a price of $39/tonne (at 50% moisture content (M.C.)), excluding transportation costs to pay for production costs. As the energy content by weight of fuel peat varies inversely with moisture


LOCATION OF ACCESSIBLE PEAT DEPOSITS
>50 Ha ON THE BURIN PENINSULA
SCALE 1:250,000
FIGURE 1
BURIN PENINSULA
BURIN DISTRICT
Garnish
Grand Bank
Marystown
Burin
Lamaline
Taylor's Bay
Lord's Cove
Point au Gaul
Allan's Island
Point May
Calmer High
Frenchman's Cove
Grand Beach
Mercer's Cove
Mooring Cove
Creston
Sali Pond
Bulls Cove
Windsor
Great Burin
Corbin
Lawrence
Rouyn Pond
Lawn
Molliers
Point Crewe
Freshwater Pond
Salmonier
Little Salmonier
Burin Island
Allan's Island
Middle Lawn Islands
- 61 -

content, the marketing of fuel peat, if sold by weight, requires the quoting of a moisture content. A transportation cost of $4.00 per tonne would be good for a delivery distance of approximately 15 km from the production site, and $6.00 per tonne for a distance of 60 km. It is anticipated that the vehicle delivering the fuel would remove the ash resulting from the burning of the fuel.

The production level of 9200 tonnes is the estimated requirement for the three facilities analyzed during the study. Once production levels from a peatfield reached 20,000 tonnes per annum the costs to produce would reduce to approximately $33/tonne (at 50% M.C.). It is expected that higher levels of production would not reduce the unit costs below the $33/tonne figure.

PEAT DEMAND

A survey of industrial, commercial and institutional fuel oil users, consuming in excess of $10,000 annually and located within the study area, was carried out to determine the fuel peat displacement potential. Forty-five organizations were queried and 15 responded. Twelve of the fifteen favourably expressed interest in a possible conversion to fuel peat. If all interested users converted, 5.2 million litres of fuel oil would be displaced, and would generate a demand for fuel peat of 20,300 tonnes (50% M.C.) per annum. Realistically the conversion rate would be less than the maximum potential and the actual demand would fall below the

Table 1 Summary of Peat Demand Survey

Contact Name	Business	Location	Litres	Tonnes
Burin Integ. Sc. Brd.	Harfett School	Salt Pond	33,663	131
Burin Integ. Sc. Brd.	Partanna Acad.	Grd. Bank	104,825	409
Burin Integ. Sc. Brd.	Jamieson Acad.	Salt Pond	126,124	493
Burin Integ. Sc. Brd.	Seaman's Elem.	Garnish	34,545	135
Burin Penin. Drycls.	Laundry	Fortune	20,000	78
Burin RC School Brd.	St. Pat's Elem.	Burin	52,890	207
Burin RC School Brd.	Holy Name of M.	Marystown	54,980	215
Federal Govt.	G.O.C. Bldg.	Grd. Bank	6,440	25
Federal Govt.	Post Office	Marystown	4,200	16
FPI Fortune	Fish Process	Fortune	1,457,844	5,695
FPI Grand Bank	Fish Process	Grd. Bank	357,021	1,395
FPI Marystown	Fish Process	Marystown	1,719,207	6,716
Housing - Burin	470 Residences	Burin	1,630,900	6,371
Housing - Fortune	405 Residences	Fortune	1,405,350	5,490
Housing - Garnish	175 Residences	Garnish	607,250	2,372
Housing - Grd. Bank	660 Residences	Grd. Bank	2,290,200	8,946
Housing - Lamaline	305 Residences	Lamaline	1,058,350	4,134
Housing - Marystown	775 Residences	Marystown	2,689,250	10,505
Housing - St. Law.	240 Residences	St. Law.	832,800	3,253
Marystown Shipyard	Ship Building	Marystown	602,130	2,352
Provincial Govt.	DVS Burin	Burin	238,483	932
Provincial Govt.	Highways Depot	Burin	19,075	75
Provincial Govt.	Cottage Hosp.	Grd. Bank	77,915	304
Provincial Govt.	Nursing Stat.	Lamaline	19,020	74
Provincial Govt.	Cottage Hosp.	St. Law.	86,184	337
Provincial Govt.	Clinic/Hosp.	Burin	41,041	160
Provincial Govt.	New Burin Hosp.	Burin	114,467	447
St Lawrence RC Par.		St. Law.	18,850	74
	Total		15,703,004	61,340

20,000 tonne per annum production goal. Therefore the scope of the survey was expanded to include the residential sector. This sector could consume 41,100 tonnes at 100% displacement of fuel oil. The maximum potential for annual fuel peat consumption is listed in Table 1 and including all sectors totals to 61,600 tonnes (at 50% M.C.) which would annually displace 15.7 million litres of fuel oil. The resource potential is identified when the 15.7 million litres of fuel oil consumed in the study area annually is compared to the resource potential of 23.5 million tonnes at 50% M.C. (6000 million litres equivalent energy content).

Of the industrial/commercial/institutional users who responded to the questionnaire a selection was made of three optimal candidates for fuel peat boiler conversion feasibility analysis. The following facilities were chosen; Jamieson Academy School - Salt Pond, F.P.I. Fishplant - Marystown, and Marystown Shipyard. These facilities provide a good mix of industrial and institutional heating plant capacities.

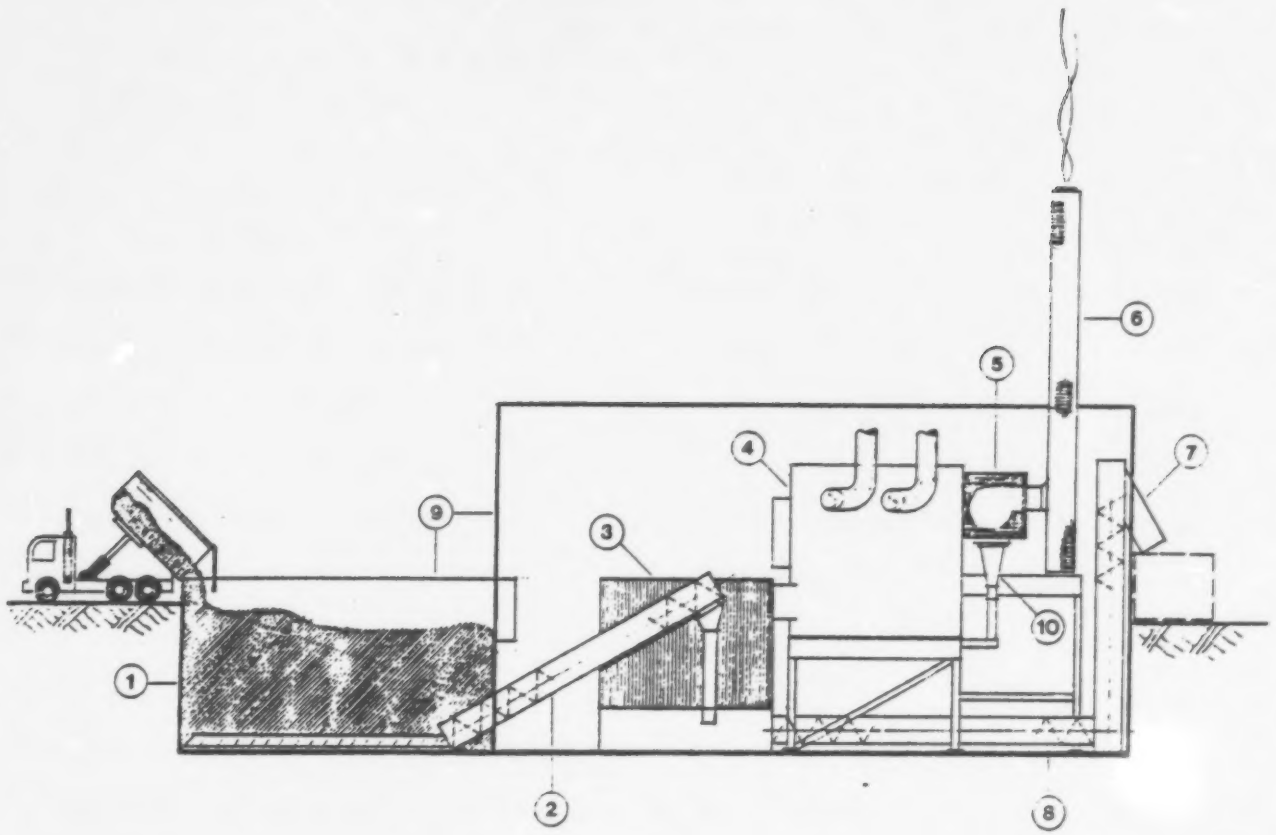
TECHNICAL CONSIDERATIONS

The peat fired heating plants are sized based on the heating plant peak seasonal efficiency as opposed to peak capacity. This results in an optimal blend of lower overall annual energy cost and initial capital cost. The trade-off is that it will be neces-

sary for 5-15% of the annual heating energy be provided by oil. The limitations for fuel peat conversion identified in the analysis consist of the relatively low cost of #6 fuel oil (Bunker "C") at the F.P.I. Fishplant as compared to #2 fuel oil (furnace oil), lack of a central heating plant at the Marystown Shipyard, and the low fuel consumption at Jamieson Academy.

The peat fired heating plant for the F.P.I. Fishplant would consist of a 4,100 kW steam boiler located in a new building adjacent to the fishplant. See Figure 2 for a schematic of a peat fired heating plant. An expected capital cost of the installation is $1,100,000 in 1986$. The new boiler will supply steam into the steam header in the existing Boiler Room nearby. This would allow the shut-down of the existing 7200 kW oil fired, steam boiler. Annual #6 fuel oil consumption for the fishplant would reduce from 1,700 thousand litres to 85 thousand litres. The remaining 85,000 litres consumption would result from an existing 1800 kW boiler being used for space heating during "down time" from fish meal production. The peat fired boiler would consume 6300 tonnes of fuel peat annually while displacing the #6 fuel oil. The expected annual cost of Operation and Maintenance costs attributable to the peat fueled boiler is $27,500.

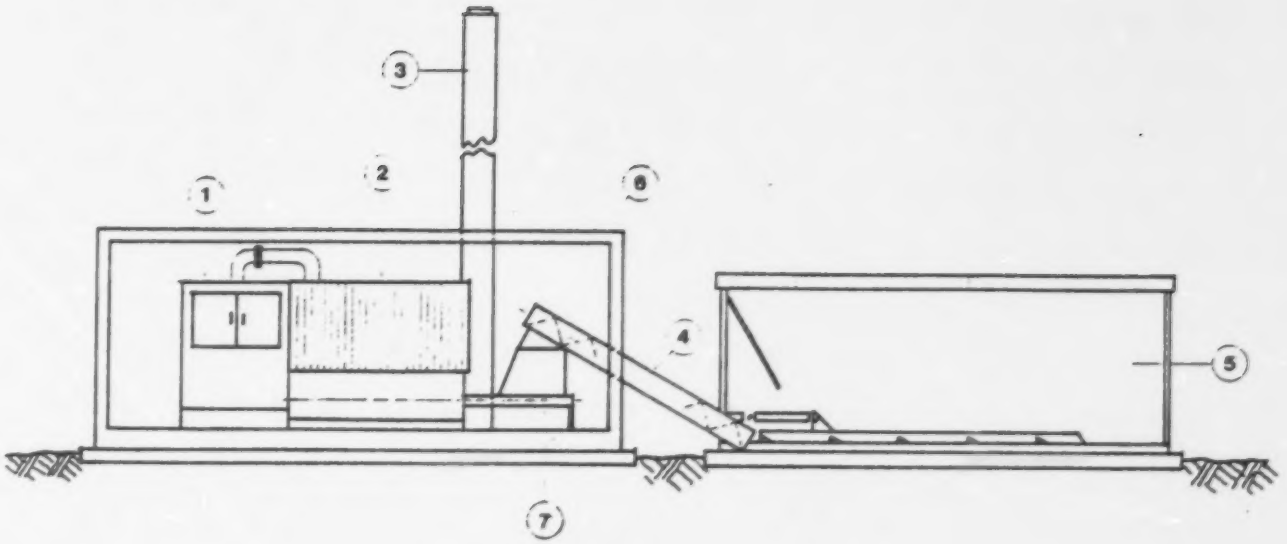
The peat fired plant for the Marystown Shipyard would consist of a steam boiler in a new building adjacent to the Main Shed with an overhead distribution system to supply steam heating to three other buildings at the facility besides the Main Shed. Plant cap-



1. SILO
2. CONVEYOR
3. COMBUSTION CHAMBER
4. HEAT EXCHANGER
5. FAN
6. STACK
7. ASH DISCHARGE
8. ASH CONVEYOR
9. SILO/HEATING PLANT BUILDING
10. FLY ASH COLLECTOR

PEAT BURNING SYSTEM

FIGURE 2a



1. BOILER
2. COMBUSTION CHAMBER
3. STACK
4. CONVEYOR
5. STORAGE SILO
6. HEATING PLANT BUILDING
7. STOKER SCREW

PEAT BURNING SYSTEM

(PORTABLE UNIT)

Figure 2b

acity of 2,060 kW is required. Annual #2 fuel oil consumption would reduce from 757,000 litres to 136,000 litres. The 136,000 litres would be consumed by the existing boilers during the peak heating season and during extended use of the large doors at the Main Shed. An annual consumption of 2400 tonnes by the peat boiler is expected. The amount of $19,700 is estimated to carry the annual Operation and Maintenance costs attributable to the peat boiler and the distribution system.

A portable peat fired plant in the form of two trailers located next to the existing boiler room was selected for Jamieson Academy. A plant capacity of 393 kW is required. Consumption of #2 fuel oil would be reduced from 126,000 litres to 6000 litres annually. This would allow the shut-down of the existing 424 kW oil fired, hot water boiler. The 6000 litres would be consumed by the existing boilers during the peak heating season. The peat fired boiler would consume 500 tonnes of fuel peat annually while displacing the #2 fuel oil. The expected annual O and M costs attributable to the peat fueled boiler is $3,400.

Although several manufacturers are available for wood fired systems, only two suppliers of peat fired systems were identified in this study. The fuel peat heating plant costs are higher than might be otherwise expected in comparison to wood systems. The plant costs may reduce as more units are installed in the Canadian Market in conjunction with the development of the resource.

LIFE CYCLE COST ANALYSIS

A financial analysis involving Life Cycle Costing techniques was used to measure the economic viability of each of the three facilities. The analysis involves the life cycle costing of each fuel peat boiler plant using a financial model to identify the Net Present Value (NPV). The financial model used is an in-house program designed around ASHRAE guidelines for Life-Cycle Costing. For a project to be viable the Net Present Value of that project must be a positive dollar value.

Financial Model Inputs and Assumptions

The inputs to the financial model for each fuel peat boiler plant are as follows:

a) Capital cost of the plant and ancillary requirements,
b) Annual displaceable fuel oil cost,
c) Annual fuel peat cost,
d) Additional annual operation and maintenance costs,
e) Period of analysis,
f) Discount rate, and
g) fuel oil, fuel peat, and O & M escalation factors.

The principal assumptions used in the financial analysis are as follows:

a) The present value of all costs and savings are in 1986$,

Table 2 Annual Net Fuel Cost Savings

Facility	Displaced Fuel Oil Cost	Fuel Peat Cost	Net Fuel Cost Savings
Jamieson Academy	42,200	15,800	26,400
FPI Fishplant	422,700	23,200	191,500
Marystown Shipyard	222,400	83,200	139,200

Table 3 Annual Incremental O & M Cost

Facility	Electricity	Maintenance	Total O & M
Jamieson Academy	$ 900	$ 2,500	$ 3,400
FPI Fishplant	$10,000	$17,500	$27,500
Marystown Shipyard	$ 6,400	$13,300	$19,700

b) The capital costs are FPI Fishplant, $1,100,000; Marystown Shipyard, $897,100; and Jamieson Academy, $225,000,

c) The cost of fuel peat delivered to the plant is $33/tonne,

d) An incremental increase in the annual O & M cost as identified in Table 1,

e) An annual fuel cost saving has been calculated for each facility, and is presented in Table 2,

f) A heating plant life of 20 years has been assumed,

g) An escalation factor of 4.5% for fuel oil and general inflation over the next 25 years was provided by Mr. A. Hutchings, Dept.of Mines & Energy Staff Economist, and

h) A discount rate of 13%.

Financial Model Outputs

The outputs of the financial modelling are presented in Table 3. Along with Present Value, Capital Cost and Net Present Value of the conversion, the following outputs are generated by the model:

a) Levelized annual cast flow,

b) Annual Net Savings over the period of analysis, in 1986$

c) Return on Investment,

d) Internal Rate of Return,

e) Benefit to Cost Ratio,

f) Simple Payback Period (SPP),

g) Real Payback Period (RPP), where

$$RPP = \ln(1+(SPP*(A-1)/A)) / \ln(A)$$

$$\text{and} \quad A = \frac{1 + \text{Fuel Oil Escalation factor}}{1 + \text{Discount Rate}}$$

The analysis has been completed based on the fuel peat heating plant capital cost, annual displaceable fuel oil cost, annual fuel peat cost, and additional operating and maintenance costs resulting from the installation of the fuel peat heating plant with the fuel oil heating plant remaining in place. For the analysis it was assumed that a peatfield will be selected in 1987, ditching starts in late 1987 or early 1988, and the heating plant construction will be complete late in 1991.

The capital costs, fuel costs, operating & maintenance costs for three fuel peat plants are presented in Tables 2 and 3. The results of the life cycle costing analysis are presented in Table 4. These results indicate that for the FPI Fishplant and Marystown Shipyard facilities are viable candidates for conversions, while the Jamieson Academy facility is not viable. The Academy's NPV is below zero, and its Internal Rate of Return is less than the Escalation Rate of 13%. The Real Payback Periods for the two viable facilities are rather high, but are well within the life of a peat fired heating plant.

Table 4 Financial Analysis Results for the Heating Plants

Output Item	Jamieson Academy	FPI Fishplant	Marystown Shipyard
Present Value	$222,531	$1,532,223	$1,154,556
Capital Cost	$225,000	$1,100,000	$ 897,100
Net Present Value	$ -2,469	$ 432,223	$ 257,456
Annual Cash Flow	$ 31,678	$ 218,118	$ 164,355
Return On Investment	14.08%	19.83%	18.32%
Internal Rate of Return	12.82%	19.14%	17.51%
Benefit to Cost Ratio	0.99	1.39	1.29
Simple Payback Period	10.63yrs	7.55yrs	8.17yrs
Real Payback Period	25.56yrs	12.17yrs	13.96yrs

Financial Sensitivity

Sensitivity Analysis was completed to measure the stability of the financial viability of the FPI Fishplant and Marystown projects. The analysis was accomplished by modifying the value of various inputs, one at a time, to the financial model in an iterative manner until the NPV of either project reached zero. The value of the input being studied at which the NPV equals zero is referred to as the "break-even value". The ratio of the "break--even value" to the initial assumption is referred to as the sensitivity factor for that input. The following model inputs were selected for sensitivity analysis; a) Capital Cost, b) Annual Displaceable Fuel Oil Cost, c) Annual Fuel Peat Cost, and d) Annual Incremental Operating and Maintenance Cost. The results of the sensitivity analysis have to be interpreted with care as the "break-even value" for any one input assumes that the other inputs to the financial model do not change.

Financial Summary

The results presented in Table 5 indicate that the two conversions can tolerate reductions in the cost of fuel oil (and potential energy cost savings) or an increase in cost in either of the other three model inputs. As they are not mutually exclu-

Table 5 Results for Sensitivity Factors

Facility	Financial Model Inputs			
	Capital Cost	Annual Fuel Oil Cost	Annual Fuel Peat Cost	Added O & M Cost
FPI Fishplant	1.39	0.76	1.18	2.50
Marystown Shipyard	1.29	0.81	1.29	2.44

Table 6 Fuel Oil Escalation Factors

YEAR	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5
1985	1.00	1.00	1.00	1.00	1.00
1986	0.95	0.90	0.90	0.80	0.80
1987	0.95	0.90	0.90	0.80	0.80
1988	0.99	0.94	0.95	0.84	0.85
1989	1.04	0.98	1.01	0.87	0.90
1990	1.08	1.03	1.07	0.91	0.95
1991	1.13	1.07	1.14	0.95	1.01
1992	1.18	1.12	1.20	1.00	1.07
1993	1.24	1.17	1.26	1.04	1.13
1994	1.29	1.22	1.35	1.09	1.20
1995	1.35	1.28	1.43	1.14	1.28
1996	1.41	1.34	1.52	1.19	1.35
1997	1.48	1.40	1.61	1.24	1.43
1998	1.54	1.46	1.71	1.30	1.52
1999	1.61	1.53	1.81	1.36	1.61
2000	1.68	1.59	1.92	1.42	1.71
2001	1.76	1.67	2.03	1.48	1.81
2002	1.84	1.74	2.16	1.55	1.92
2003	1.92	1.82	2.29	1.62	2.03
2004	2.01	1.90	2.42	1.69	2.15
2005	2.10	1.99	2.57	1.77	2.28
2006	2.19	2.08	2.72	1.85	2.42
2007	2.29	2.17	2.89	1.93	2.57
2008	2.39	2.27	3.06	2.02	2.72
2009	2.50	2.37	3.24	2.11	2.88
2010	2.61	2.48	3.44	2.20	3.06
2011	2.73	2.59	3.64	2.30	3.24

sive, the tabulated sensitivity factors above are maximum limits on deviations from the initial assumptions to the financial model that either project can withstand and maintain viability.

Further sensitivity analysis was completed on the impact of fuel oil price fluctuations. The five fuel oil escalation scenarios considered to the year 2011 are listed in Table 6. The first scenario, Case 1 (produced in consultation with the Department of Mines and Energy), is equal to the escalation factors used in the initial analysis. These five cases of fuel oil escalation were inputted into the financial model for each of the three models and the Net Present Value was recorded. The results presented in Table 7 indicate the two viable facilities can withstand fuel oil costs dropping down to at least 80% of 1985 annual costs. The results of Cases 3 and 5 show that all three facilities are financially viable conversions if fuel oil escalates at a rate higher than general inflation over the life of the project.

CONCLUSIONS

This report quantified the fuel peat resource and the potential demand for the indigenous fuel in the southern Burin Peninsula study area, together with the viability of installing fuel peat heating plants in existing facilities.

Table 7 Sensitivity of Projects NPV to Fuel Oil Cost Escalation

Facility	Case 1	Case 2	Case 3	Case 4	Case 5
Jamieson Academy	$-2,000	$-16,000	$60,000	$-44,000	$24,000
FPI Fishplant	$432,000	$338,000	$1,105,000	$146,000	$828,000
Marystown Shipyard	$257,000	$184,000	$586,000	$41,000	$398,000

There is a fuel peat resource of high energy potential in the southern Burin Peninsula. There are 39 peatfields in the study area that are sufficiently large to allow annual production of 6,000 tonnes of fuel peat (at 50% M.C.). The production goal of 20,000 tonnes annually is needed to minimize the production costs of fuel peat. There are nine peatfields that are large enough to produce this quantity of fuel peat.

The industrial/commercial/institutional users within the study area, who consume at least $10,000 per annum of fuel oil, jointly consume a total of 5.2 million litres. This fuel oil consumption is equivalent to 20,500 tonnes of fuel peat (at 50% M.C.). Including the residential sector, the fuel peat equivalent consumption in the study area is 61,600 tonnes/annum (at 50% M.C.). The conversion of 32% of the energy consumption from all sectors to fuel peat would support the production of a viable fuel peat mining operation.

The results of the technical and financial analysis indicate that it is viable to install peat fired heating plants. However with the present cost of smaller fuel peat heating plants (less than 700 kW), retrofit applications are not viable. Retrofitting of plants larger than 1,400 kW capacity are financially viable. This is a lower capital cost in comparison to that of retrofit applications.

Of the three facilities studied; FPI Fishplant - Marystown consumes 1.70 million litres of #6 fuel oil, and Jamieson Academy - Salt Pond and Marystown Shipyard consume 0.62 million litres of #2 fuel oil. The Academy is the only facility not financially viable. The fuel peat boiler for the Fishplant is required to be a steam plant of 4,100 kW capacity. An enclosing building is required. For the Shipyard, the required steam boiler capacity is 2,060 kW to generate steam for a distribution system to heat the Main Shed and the Outfitting, Office and Service Buildings. The two facilities would have an annual consumption of 8,700 tonnes of fuel peat. The cost of fuel peat to the facilities reviewed in the study would be $33/tonne. It was assumed that there would be a $10/tonne subsidy until demand for the fuel increased, driving annual production up to the 20,000 tonne level.

The financial viability of the Shipyard heating plant conversion is such that the capital cost could increase by upto $260,000 or the price of fuel oil could decrease by 19% and the project would remain viable. The financial viability of a heating plant conversion for the Fishplant is such that the capital cost could sustain an increase of upto $429,000 or the price of fuel oil could decrease by 24% and the project would remain viable.

Woodchip Production and Transportation in Newfoundland

Overview

for the

Wood and Peat Energy Conference

November 18, 1986

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Chipping Production and Transportation in Newfoundland

REVIEW

Wood chip production began in Newfoundland in 1978 with the trial of the Morbark 22 Chiparvester at Price Nfld. Ltd (now Abitibi-Price), approximately 7,000 tonnes were produced. That operation has not stopped production but many changes have been made. Since then several other consumers have started to use wood chips as a source of fuel. The names and yearly capacities of present woodchip users are as follows:

1.	Abitibi-Price (Grand Falls)	50,000 tonnes
2.	Corner Brook Pulp and Paper	25,000 tonnes
3.	Gander Hospital	3,200 tonnes
4.	Nfld. Hardwoods	5,000 tonnes
	1985 Total	83,200 tonnes

PRODUCTION

Equipment

There are two main types of chipping equipment as follows:

1. Disk chippers

2. Drum chippers

The two makes chippers used mainly in the province have been the Morbark and the Bruks. Morbark has a wide range of chippers of which the following machines have been used in the province:

1. Morbark 22
2. Morbark 20
3. Morbark Super Beever
4. Morbark Beever

Bruks has had a variety of its machines used as well. The biggest potential for the Bruks machines seems to be in the area of terrain chipping. The Bruks 800 was recently tested by the Department of Forest Resources and Lands, Forest Products Division and it has considerable promise as a terrain chipper in the province.

Cost

The cost per tonne is the yard stick which the success of any chipping project is measured. Costs in Newfoundland have on the average been higher then comparable projects in the rest of Canada and the U.S..

Costs have varied so dramatically that it is difficult to analyize for trends. The main factor for the higher costs is the learning curve which applies to any new technology.

While the main users would not wish to mention the costs of wood chips at their facilities the cost in Newfoundland varies from $26/tonne

to as high as $34.50/tonne. The reasons for the costs differences are as follows:

1. The greater the production the lower the cost. Costs in the vicinity of $26/tonne are less than 40 miles truck haul and greater than 7,500 tonnes per year production per operator.

2. There is not sufficent market to provide a good competitive base. In most cases their is only one supplier per facility.

3. Sawmill residue is not being utilized as efficiently as it could be. It is a cheaper or should be a cheaper residue supply.

On the mainland of Canada woodchip costs are in the vicinity of $20.00/tonne for high capacity operations trucking 60 miles. Sawmill residue sells for as low as $6.00/tonne.

In Newfoundland the costs should be in the range of $28-$30 tonne for smaller operations and $22-$24 tonne for large capacity operations. Residue should sell for a different price then wood chips in the range of $10-$15 tonne.

TRANSPORTATION

Trucking

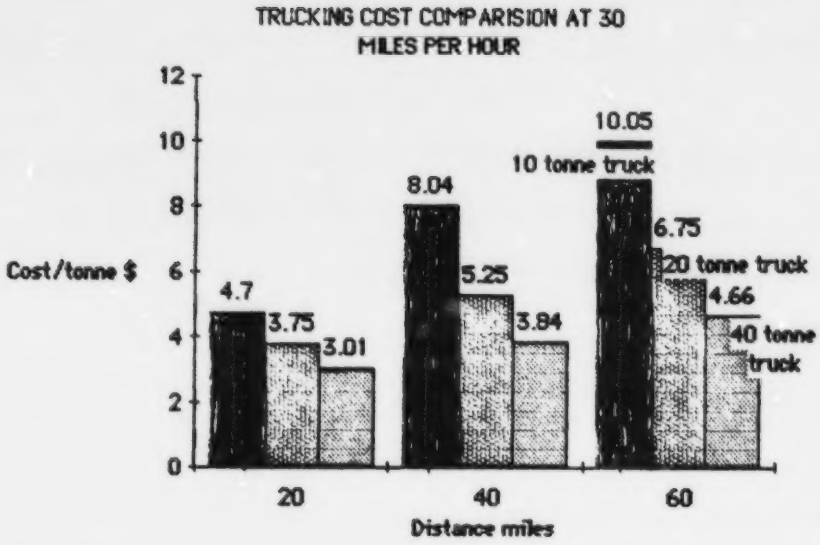
The transportation of wood chips has been somewhat of a problem. In initial stages of the development of the industry the following problems were encountered:

1. The capital cost of purchasing large trailers for hauling chips was prohibitive because of the experimental nature of the projects. This did not provide the savings which would have been realized.
2. When large vans were incorporated into the hauling system unloading became a problem. A chip van dumper was necessary to increase productivity.
3. On smaller operations a self dumping truck was necessary which increased trucking costs.
4. When hauling over the highway was required government regulations restricted the number of liscenced carriers which hindered trucking flexibility and competition. Hence costs were high.

Cost

The cost of trucking wood chips has been reduced substaintially since the beginning of the industry. The lifting of government restrictions on trucking has helped. Also the installation of chip van dumpers at large users such as Abitibi-Price has improved the productivity of the trucking operation from all suppliers.

The biggest cost differencial at present is the use of 10 tonne self dumping trucks and 20 tonne semi trailers. The greatest improvement would be the use of 40 tonne trailer vans. The following graph shows the cost differential from 20 to 60 miles travelling at 30 mph using 10, 20 and 40 tonne capacity trucks.



From the graph it can be seen that the use of smaller trucks is not the best trucking method over long distances. However there must be a sufficient volume to justify a chipvan dumper to initiate the savings. It is obvious that to include suppliers over twenty miles from the consumer, trailer van should be considered. Also suppliers at 60 miles are competitive with small truck operaters at 20 miles. Again the volumes must be there to justify the capital expenditure.

FUTURE

The future production of chips and the costs for transportation are dependant on the following factors.

1. More boiler conversions to provide a greater chipping market
2. Greater use of sawmill residue
3. Head for the $24.00/tonne figure in conventional chipping operations

4. Present suppliers should aim to purchase sawmill residue as part of their supply contract to increase revenue and provide income for sawmill operations.

5. Terrain chipping should be promoted in the private sector

6. The use of stumps for residue should be investigated

7. The ideal would be total tree chipping for pulpmills with usable chips and residue separated at the mill.

Peat Land Inventory

Overview

Methodology and Application
Newfoundland

for the

Wood and Peat Energy Conference

November 18, 1986

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ABSTRACT

The island portion of the province of Newfoundland and Labrador was inventoried for peatland deposits from 1978-1983. The total number of deposits mapped were 67,771 covering 1,114,990 hectares or 11% of the land mass of the island. The total volume of peat is 15.2 billion cubic metres consisting of 6.8 billion cubic meters of horticultural peat and 8.5 billion cubic metres of fuel peat. All peat deposits have been classified into bog, fen, marsh and swamp types in accordance with the National Wetland Classification System (Tarnocai 1980). The data is presently being used for assessment of peat fuel potential and resource planning for the island of Newfoundland.

INTRODUCTION

Peatlands form a large component of the island of Newfoundland; 11% of the land mass or 1,114,990 hectares. These peatlands however, have not contributed significantly to resource development within this province. Several small sites have been ditched for forestry purposes and a large agricultural research area has been established in eastern Newfoundland. At present, peat is being harvested on a large scale on only two sites. Hi-point Peat in Bishop Falls are producing milled peat mainly for industrial purposes although some fuel peat have been produced. The second site is the Avalon Peat harvesting project at St. Shotts which is the first attempt in Newfoundland to produce sod peat for both the domestic and commercial market.

Thirty to forty years ago peatlands were used locally in southeastern Newfoundland as a fuel supplement, but with increasing utilization of oil and natural gas which, until recently was relatively inexpensive, the use of peat for energy has disappeared.

In recent years, however, rapidly increasing oil prices coupled with uncertainties of future oil supplies, as well as the need for more

effective land resource management have led to a reassessment of our peatlands for energy or resource needs. Although very little emphasis has been directed toward assessing the potential of peatlands as an alternate source of energy in Newfoundland, a six-year peatland inventory of the Island part of Newfoundland and Labrador was initiated in 1978 by the Newfoundland government and funded under the Federal-Provincial General Development Agreement. The principal objectives of this inventory were to determine the location and area of peatland deposits, to provide estimates of volume for each major peatland type, and to provide data to facilitate the needs of resource planners.

Inventory Methodology

Peatland deposits have been inventoried for six regions of the island and the results are as follows (See Figure 1):

1978 Northeastern	# of deposits	- 19,577
	# of Ha	- 135,493
	% land mass	- 12%
	Horticulture Peat	- 2.2 billion cubic meters
	Fuel Peat	- 989.8 million cubic meters
1979 Western	# of deposits	- 6,407
	# of Ha	- 87,885
	% land mass	- 9.3%
	Horticulture Peat	- 962.7 million cubic meters
	Fuel Peat	- 796.6 million cubic meters
1980 Eastern	# of deposits	- 17,525
	# of Ha	- 273,358
	% land mass	- 14.4%
	Horticulture Peat	- 1.3 billion cubic meters
	Fuel Peat	- 2.8 billion cubic meters

1981 Northern	# of deposits	- 9,538
	# of Ha	- 126,844
	% land mass	- 9.6%
	Horticulture Peat	- 804.9 million cubic meters
	Fuel Peat	- 1.07 billion cubic meters
1982 South Central Part I	# of deposits	- 14,724
	# of Ha	- 322,816
	% land mass	- 13.5%
	Horticulture Peat	- 1.5 billion cubic meters
	Fuel Peat	- 2.8 billion cubic meters
1983 Southcentral Part II*	# of deposits	- 569
	# of Ha	- 168,594
	% land mass	- 7.2%
	Horticulture Peat	- 5.6 million cubic meters
	Fuel Peat	- 12.2 million cubic meters

***Only deposits 30 ha and larger were mapped and at a scale of 1:50,000 whereas the previous five areas were 1 ha and larger and mapping was at a scale of 1:12,500.**

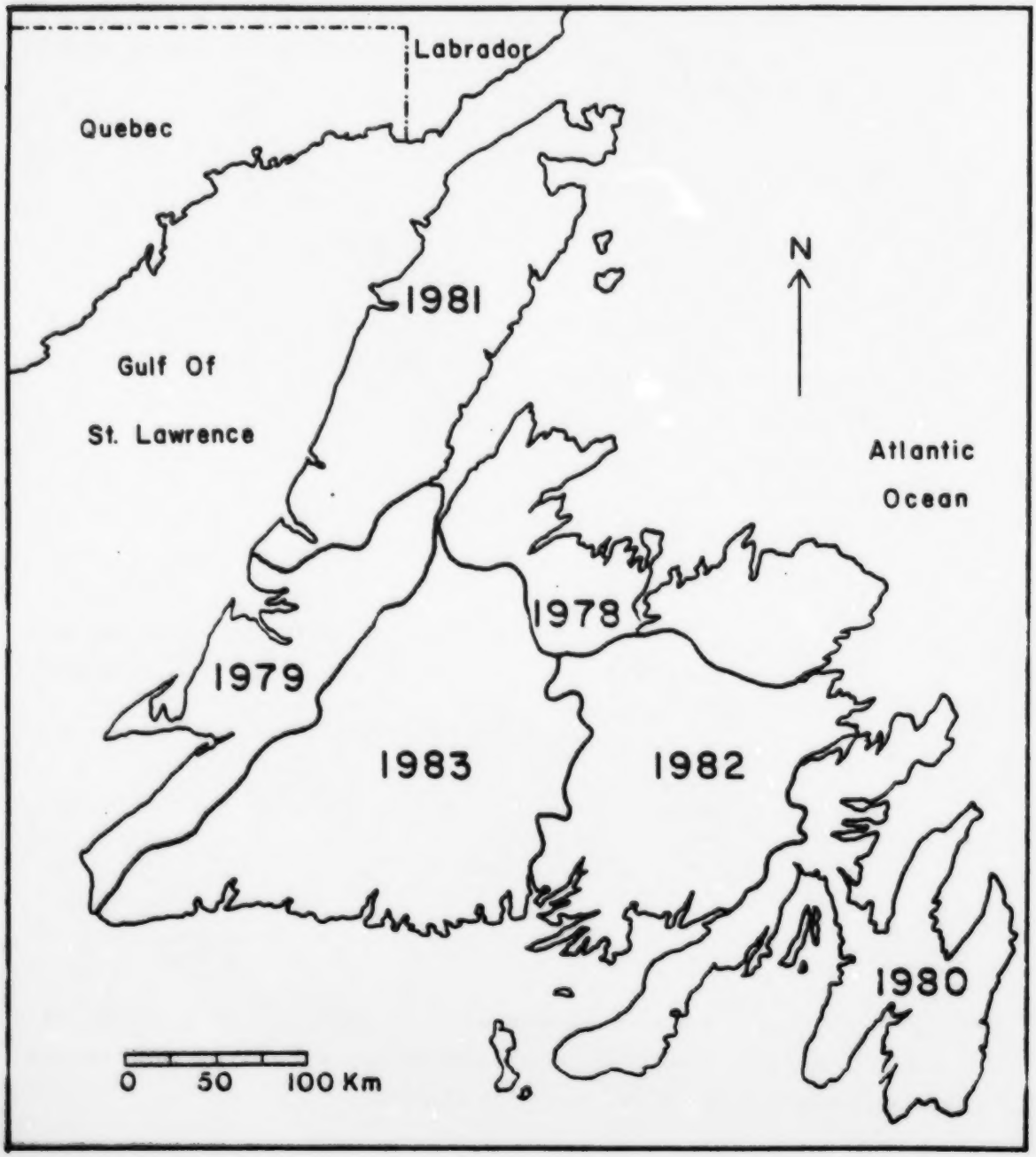


Figure 1: Map of insular Newfoundland showing peatland inventory schedule.

The inventory consisted of four work phases.

I. Delineation of ecodistricts.
II. Aerial photo interpretation and mapping.
III. Field surveys.
IV. Data compilation.

I. Delineation of Ecodistricts

In order to derive maximum value from the field sampling program an ecodistrict map was prepared for the entire study area. Ecodistricts are components of an ecoregion, characterized by a distinctive pattern of relief, geological structure, geomorphic evolution and associated vegetational complexes. These districts served as a primary stratification of the land surface, and the field-sampling intensity was dictated by the area of peatland within each of the districts.

II. Aerial Photo Interpretation and Mapping

Two distinct, but related tasks were involved in this phase: (a) air photo interpretation, and (b) mapping.

Air Photo Interpretation - Preliminary air photo interpretation using high level 1:110,000 colour photography and 1:50,000 black and white photographs was undertaken. This provided an overview of the types and distribution of the various wetland deposits within each ecodistrict. Upon completion of the preliminary interpretation, field checks were undertaken to gather additional ground truth data and to confirm the preliminary interpretation.

The second task in the air photo interpretation involved the delineation of the boundaries and classification of the wetlands deposits. All deposits greater than 1.0 ha were classified. Interpretation was made using 1:12,500 colour and

1:15,840 black and white photography. This segment of the interpretation along with the overview, provided the basis for the design and planning of the field survey phase.

The classification of wetland types followed the wetland types outlined in the Canadian Wetland Registry as developed by the Wetland Classification System (Tarnocai 1980).

The scale of interpretation did not permit a clear separation of bog and fen components especially where both peatland types formed extensive peatland complexes. These deposits were delineated and classified as complexes. For example, a "Domed Bog-Ladder Fen Complex" would be designated as DB-LF indicating that the domed bog comprised the larger portion of the complex.

The area of each deposit was measured using a conventional dot grid. In addition, designations were assigned to the larger deposits (i.e. bogs > 30 ha and fen > 5 ha). These designations reflected type, drainage and restriction, percentage of open surface water, pool pattern, percent slope and direction. The following system was used:

Type - Wetland Classification System

Drainage Limitation	Pool Patterns
a - low	C - Concentric
b - moderate	E - Eccentric
c - severe	I - Irregular
	P - Parallel

Aspect	Slope
Eight point compass method	Degrees

Water Areas

Percentage of surface

A typical designation for a larger deposit could be:

1 APLB 110.5 ha c 40% I 2^{o} NE

(Deposit #1, an Atlantic Plateau Bog, 110.5 ha in area with severe drainage limitations, 40% surface water with irregular pool patterns, slope is approximately 2% in a northeasterly direction).

Mapping - Once the interpretation was completed the data was transferred from the photographs to a forest inventory cover type map at a scale of 1:12,500. A base map of the same scale was prepared and all the peatland classification drafted on. The objective was to have on file a complete set of maps for the Island, at a scale of 1:12,500 showing classification, area and location of all wetland deposits greater than 1.0 ha.

III. Field Survey

Field sampling was conducted by two 2-man teams. Ecodistricts were stratified throughout the study area according to the percentage of deposits occurring within each district. Wherever possible, all wetland types occurring within a district were sampled. A helicopter was used to reach inaccessible areas.

Field sample points were located on organic deposits using a variable grid system. The size of the grid varied with the size of the deposit. Sample deposits were outlined on 1:15,840 black and white aerial photographs and the appropriate grid was used to mark the location of the sampling points. The field crews then used the photographs to accurately locate the sample points.

At each sample station on the established grid, a depth sounding was taken and the following information recorded:

1) Deposit number
2) Grid reference number
3) Depth of stratum (cm)
4) Type of bottom materials
5) General comments

In all, 2074 depth soundings were taken during the Eastern Region study.

Samples were taken along the major axis of the deposit, or where changes in strata occurred, the major strata (more than 0.5 m) were sampled by means of a 1 m Hiller sampler and the following information recorded:

1) Deposit number
2) Grid reference number
3) Depth of stratum (cm)
4) Colour of stratum (Munsell colour notations)
5) von Post scale of humification
6) C.S.S.C. classification
7) Total depth (metres)
8) General comments

During the Eastern Region study, 711 samples were recorded in this manner.

At each of these stations a 250-400 gram sample was collected for each of the major strata (more than 0.5 m in thickness).

These samples were placed in plastic sample bags and labelled as follows:

1) Deposit number
2) Grid reference number
3) Depth of stratum (cm)
4) Stratum thickness (cm)

5) C.S.S.C. classification -

IV. Data Compilation and Presentation

The volume of fibric (H1-4), mesic (H5-7), and humic (H8-10) peat was calculated from the detailed core measurements by constructing a profile of the depths at each profile type. The proportion of each type was multiplied by the total deposit area to obtain the volume of fibric, mesic and humic material in the deposit. Field checks on peatland deposits inventoried in more detail during earlier horticultural peat surveys (Pollett 1968), determined that the present survey volumes were within 6% of the detailed volume estimates. This data was then presented in a report format. See the following example.

Application of Inventory Data

This paper has presented the methodology of the peatland inventory in Newfoundland. The information generated by the inventory is now stored with the Department of Mines and Energy in St. John's.

Using the available information on location and quantities of peat, area ratings can be prepared (See Figure 2 and 3) and furthermore, using site specific information it is also possible to focus on potential locations for industrial development. Similarly, information can be extracted for assessment of other resource uses of peat such as forestry, agriculture, wildlife and conservation.

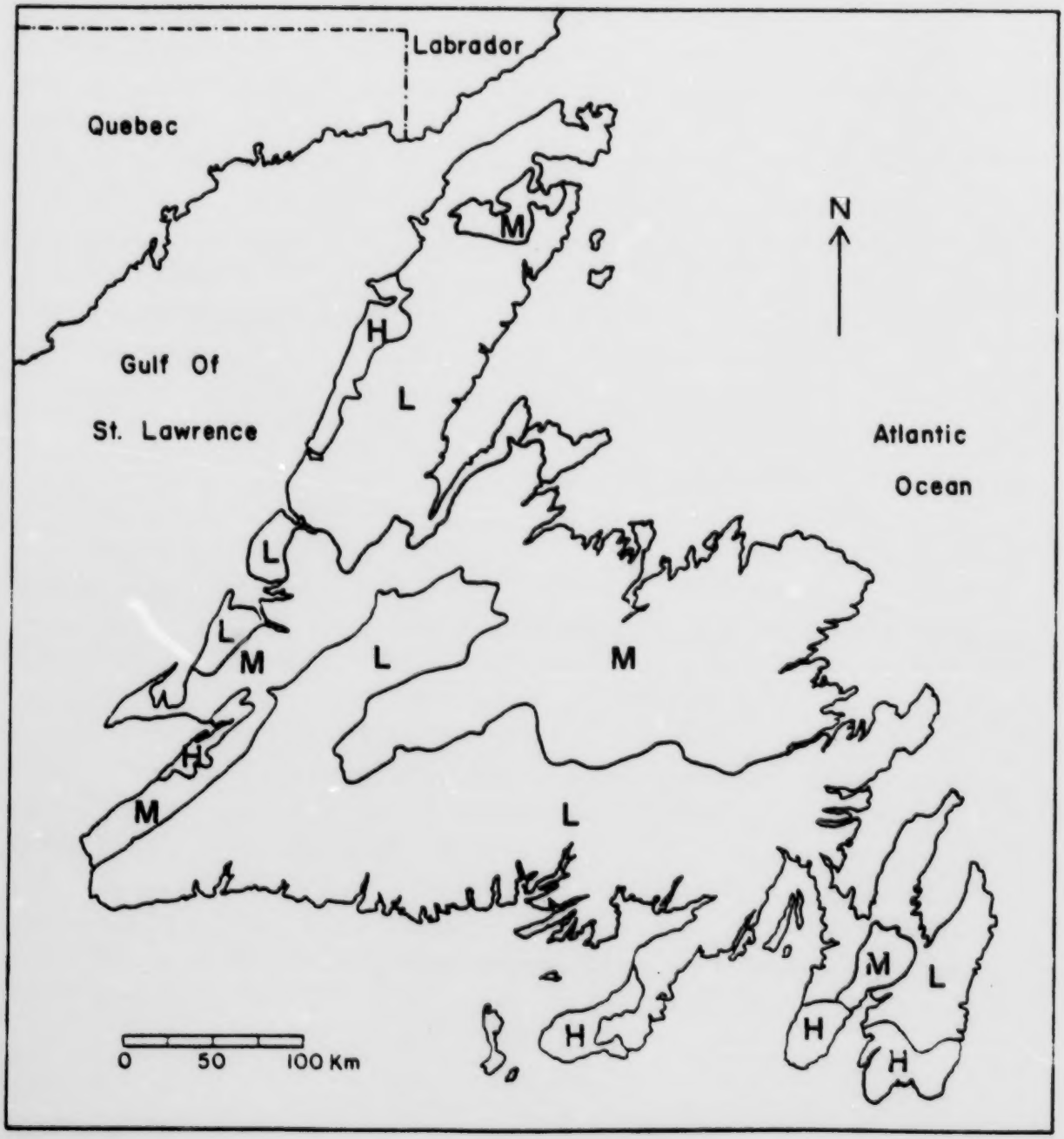


Figure 2. Areas of fuel peat reserves in Newfoundland: high (H), medium (M), low (L) (after Wells and Vardy 1981).

Figure 5: Major fuel peat concentrations and energy potential (after Wells and Vardy 1981).

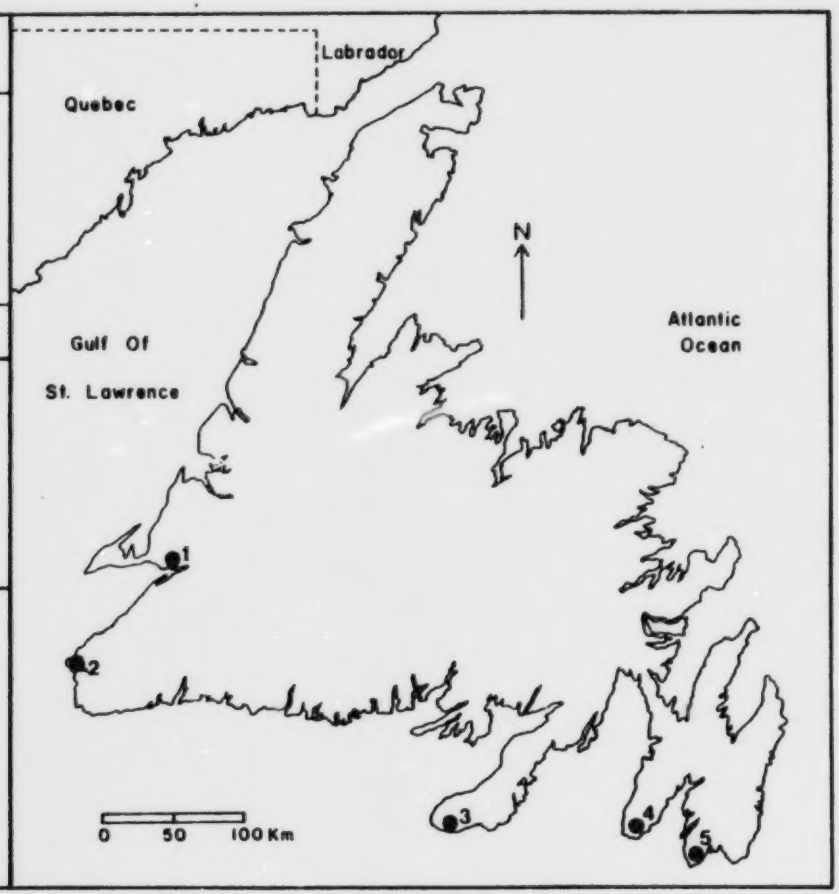
Location	Peat fuel reserves (m^3)	Barrels oil equivalent*	Millions KWH annually	Plant life
1. Stephenville	72 770 100	26 200 000	406	25
2. Codroy	45 418 500	16 350 000	252	25
3. Lamaline**	75 000 000	27 000 000	420	25
4. Branch**	75 000 000	27 000 000	420	25
5. St. Shotts**	75 000 000	27 000 000	420	25
Total	343 188 600	123 550 000	1 918	

Total peat reserves in all five locations = 123 550 000 (barrels oil equivalent)

Total energy consumption in Newfoundland, 1979 = 18 250 000 (barrels oil equivalent)

Conversion factors for peat (m^3) in situ to barrels oil equivalent = 0.36 (based on figures from Montreal Engineering study of peat bogs in northeast New Brunswick; and, "Energy From Peat in Finland" published by VTT, Technical Research Center of Finland) (See Figure 4).

**Preliminary estimates; peatland survey not completed. (Figure courtesy of Northland Associates Ltd., St. John's, Nfld.)



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Fuel Peat Harvesting

Project Report

St. Shotts Peat Project
St. Shotts, Newfoundland

for the

Wood and Peat Energy Conference

November 18, 1986

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HARVESTING FUEL PEAT AT ST. SHOTTS

The use of peat as a fuel dates back hundreds of years in Newfoundland, particularly on the Southern Avalon and Burin Peninsulas where residents traditionally had cut peat to supplement their wood supply for domestic use.

The blanket bogs near St. Shotts on the Southern Avalon contains, some of the higher quality peats known today.

In 1982 the Southern Avalon Development Association, through Avalon Peat Harvesting began developing these bogs as a sod fuel peat demonstration project.

The first stage in development is ditching the bog for better drainage. To do this a Dondi ditcher is used as well as a Kubota excavator.

After ditching, the bog surface is prepared using a screw profiler, and finally smoothed by using a grader. All attachments are pulled by a 75HP Kubota farm tractor.

After levelling the surface, the actual extruding (or cutting) of peat sods takes place. For this operation an Irish extruder known as the Herbst Super Cutter is used.

The extruder is like a massive chain saw with a 42 inch blade that extends into the bog, bringing the peat onto an auger enclosed in a tube where the peat is macerated and then extruded through a six-piped 4 inch diameter extruding system. As the peat is extruded a wheel-shaped marker system cuts or marks the sod in uniform lengths.

After drying the sods shrink and separate which allows for easy turning and further drying. The dry peat sod is approximately 2-2 1/2 inches in diameter and 8-9 inches long.

Peat once dried, forms a crust which prevents the sod from readily re-absorbing moisture.

The peat is dried to a moisture content on the range of 40-50% and then collected and stockpiled.

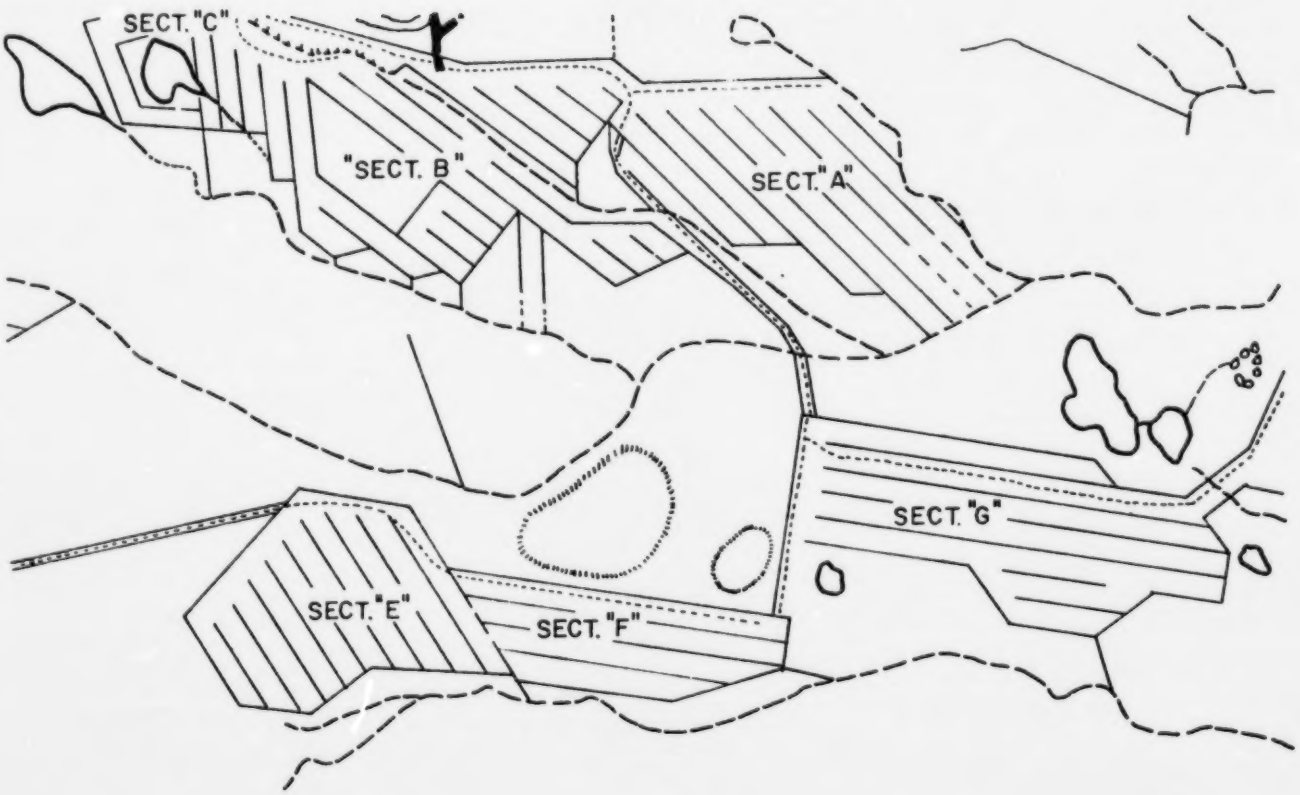
Another method employed in producing sod fuel peat is the family plotting, whereby the company extrudes the peat and sells it "as is-where-is". A family purchases the peat and is responsible for turning, stacking, collecting and stockpiling the peat for their winter use.

When thinking of sod fuel peat and the burning of our bogs for energy, one must consider what happens to the land afterwards. In Ireland, one of the most striking things about peat development is the land reclamation process.

Once the peat has been harvested for sufficient number of times to reduce the deposit to approximately 18 inches, the remaining peat is deep-ploughed with the underlying soil - in the Irish case - a silty clay.

The ploughing is done using a huge tractor equipped with a massive plough capable of ploughing to a depth of 3 feet. The silty clay is then left to dry and after two to three weeks (depending on the weather) a disc Harrow is used to further mix the peat and clay. Following the harrowing a sieve plough is used to do final levelling of the surface. The fields are then limed, fertilized and sown with grass seed; or vegetables are planted depending on the use of the particular field - for example the planting of onions. Numerous fields are developed for grass lands and one of the major spin-off industries is the Bull Beef Enterprise.
Newfoundland with its vast peat reserves has great potential for peat development and land reclamation.

St. Shotts Fuel Peat Production Ditching Plan



Energy Forests

An Overview

for the

Wood and Peat Energy Conference

November 19, 1986

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ENERGY FORESTS

R.S. van Nostrand[1]

ABSTRACT

Growing short-rotation forest crops to maximize biomass on a large scale for energy is a relatively new concept which began in Scandinavia, Ireland, and England about 15 years ago. Promising results from these European trials provided the initiative for research in energy crops in Newfoundland which began about six years ago using willows (Salix spp.). Yields of up to 20 t (DM)/ha/yr have been demonstrated, but a mean production level of 8 to 12 t (DM)/ha/yr is a practical objective. In addition to field trials, emphasis is also being placed on biogeographical and biometeorological studies to ensure best clone/site matching. Large-scale establishment of energy plantations in Canada is unlikely in the medium term, however, they could have limited application in areas which have high-cost fossil fuel requirements, but have limited access to conventional forest crops which could be used as an alternative energy source.

INTRODUCTION

Short-rotation woody crops grown to maximize yield is an art hundreds of years old in Europe and Asia where willows are still grown for basketry and fuelwood. Closer to home, the well established hybrid poplar program in eastern Ontario and southern Quebec began as a perceived need to increase productivity of fibre for pulp and paper, primarily on abandoned farmlands. The Newfoundland program began as a search for suitable species to serve as shelterbelts around cultivated peat and heathlands.

The idea of growing such crops specifically for energy is quite new and probably began in Scandinavia and Britain about 15 years ago. It is interesting to note that two forested nations, Sweden and Finland, are world leaders not only in developing machines and systems to harvest forest

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[1]Research Scientist, Newfoundland Forestry Centre, St. John's.

biomass residues for fuel, but are also leaders in growing and promoting the concept of energy plantations. Sweden, in particular, has many thousands of hectares of idle farmland as a result of overproduction of food. Dr. Gustav Siren, the father of energy forests in Sweden, believes that 500 000 ha of this farmland planted to energy crops could produce biomass fuel equivalent to 20% of their imported fuel oil. I should point out that not all foresters in Sweden agree with Dr. Siren on the need for energy plantations, and hence it has been somewhat of an uphill struggle. However, he now claims that resistance to the idea is waning.

THE RATIONALE

The concept of growing forest crops for energy may seem rather far-fetched to many, since Canada is well known as the second most forested nation on earth. So my first task is to explain why we in Newfoundland feel there is a need for this type of research and development.

With the aid of numerous federally and provincially funded incentive programs over the past several years, the amount of forest biomass being used to produce energy in Canada is increasing, in spite of the vagaries of the petroleum industry. By the turn of the century it is expected that as much as 10% of our total energy needs may be derived from biomass. Currently it is about 4%.

Most of this biomass comes from sawmill and pulpmill wastes, logging residues, and from underutilized species such as poplar and birch. In many areas mill wastes are already fully utilized, thus any increase must come from logging residues and from underutilized species. Salvaging

of logging residues for energy is becoming commonplace across Canada as technology develops to harvest it economically. It has been estimated by G.M. Bonner (1985) that the nonmerchantable portion of merchantable trees growing on productive accessible forest land can supply 25% of Canada's annual energy requirements on a sustained basis. However, this biomass is, of course, not strategically distributed. In addition, the big unanswered question is what effect will repeated removal of this biomass have on site productivity over the long term. There is mounting evidence to suggest that, generally, it will be detrimental on most sites.

The harvesting of underutilized species and "junk forest" is also increasing as a source of fuel for both industrial/commercial and domestic use. In some regions, the end is already in sight for an economical accessible supply. As the "junk forest" is harvested and sites become rehabilitated, and as areas of "noncommercial" species are converted to "commercial" species, where will the biomass fuel come from when demand is expected to more than double?

I'm not suggesting that energy forests make sense universally in Canada, but there are areas where wood grown specifically for fuel could be attractive from the point of view of socio-economic values. Such areas would include communities on the Newfoundland and Labrador coast where the cost of fuel oil is prohibitive and wood supply is limited or nonexistent.

THE NEWFOUNDLAND EXPERIENCE

As a result of visits to Scandinavia and England in 1980, Mr. Sandy Robertson[2] became convinced of the feasibility of growing energy crops in Newfoundland. It is through his perseverance and with the financial support of the ENFOR Program of the Canadian Forestry Service, that the Newfoundland energy forest project has reached its present state. Since the project's inception, collaboration has been close with Long Ashton Research Station, Bristol, England and the Swedish University of Agricultural Sciences, Uppsala, Sweden, and with other institutions for the supply of willow clones.

Choosing a Species

For the Newfoundland trials, the genus Salix (willows) was chosen for the following reasons:

1) It is a predominantly northern genus with a wide ecological range and high genetic variability, and most species are well suited to the short growing season and cold winters of the boreal forest region;
2) Salix plantations are established by unrooted cuttings which are easy to propagate and mass produce, and which revegetate rapidly as coppice growth after harvesting. They provide high yielding crops on a two- to three-year rotation for many generations without replanting;
3) In the boreal region, willows will thrive on poor and fairly exposed barren soils including peatland and heathland where commercial species cannot reach merchantable size.

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[2]Research Scientist, Newfoundland Forestry Centre, St. John's.

Since 1981, the Newfoundland program to evaluate willows for agroforestry and community shelterbelts has acquired more than 200 clones from European, American and local sources and these are being evaluated in nursery trials. A small number of the most promising clones have been selected and are being tested in plantation trials at various locations across the Island. The Newfoundland studies are testing both osier and tree-form willows. To date the osier type appears to hold the most promise for large-scale production.

The Plantations

A major difference in establishing and maintaining short-rotation energy crops compared to growing conventional species is in the intensity of cultivation. This is where a recently coined phrase "farming the forest" becomes a reality. Sites must be prepared as for agricultural crops. On cutovers, stumps and large rocks must be removed, and the soil leveled. This preparation is necessary to accommodate planting and harvesting machinery. Initial liming of the soil is usually necessary, as well as periodic fertilization. The planting stock consists of pencil-sized cuttings about 25 cm long, cut from one-year old shoots. These are simply pushed vertically into a hole made with a dibble. Optimum spacing appears to be 25 000 - 35 000 stools/ha. Weed control, particularly for the first year after planting, is essential. It is evident that the initial cost of establishing an energy plantation is considerably greater than that for a comparable conventional plantation. However this major disadvantage is offset by the following advantages:

1) Once established, the willow stools are self-perpetuating for many rotations, e.g. in England there are stools at least 200 years old.
2) Crops can be harvested every 2-3 years.
3) Willows can be grown successfully on sites not suitable for agriculture or conventional forest crops.
4) The annual leaf fall contributes to soil amelioration and can improve the site quality over a period of time.
5) Willows can flower during their second growing season, which implies that genetic crossing becomes possible and new clones tested in a short period of time.
6) The stools can be interplanted with alder (Alnus spp.) or legumes to promote biological nitrogen fixation, thus reducing the need for fertilization.

Yields

A good upland natural black spruce or balsam fir stand in Newfoundland will produce approximately two tonnes dry matter per ha/yr after 60 years. With intensive silvicultural treatment on the same site after planting or spacing we might expect a maximum of four tonnes dry matter per ha/yr including foliage.

In Swedish trials, values as high as 20 tonnes (DM)/ha/yr after three years have been achieved, and this does not include foliage weight. Dr. Siren uses a value of 15 t (DM)/ha/yr as a reasonable average to expect for Salix energy plantations in southern Sweden.

The following table gives results from the nursery stooling beds at Pasadena in western Newfoundland located on our best soils.

THREE-YEAR OLD *SALIX*
PASADENA, NEWFOUNDLAND

Species	25 000 stems/ha (t DM/ha/yr)*	35 000 stems/ha (t DM/ha/yr)*	Mean height (cm)
S. elegantissina	27	38	475
S. alba	11	15	446
S. fragilis	9	13	404
S. triandra	8	12	388
S. viminalis	8	11	398
S. nigra	2	3	318

*Estimated weights after leaf fall based on test plots planted at 25 000 stems/ha.

Trials to date in Newfoundland indicate that we might expect 8-12 t (DM)/ha/yr at three year rotations on average sites. This is 2-3 times the yield of cultivated native softwoods.

Other Studies

Initially the overall objective was to select high yielding clones and assess their performance over a broad range of environmental conditions such as cutovers, peatlands and heathlands, and agricultural sites. The program has since been broadened to reflect the full scope of research and development necessary for establishing economically viable energy plantations.

A greater emphasis is being placed on biogeographical and biometeorological studies to ensure the best clone/site matching. Limited socio-economic studies have been conducted including basic analyses of land availablility, market potential, energy audits of potential institutional users to determine biomass energy requiremnts, and economics of production, harvesting and utilization (Dyer, 1983 and Dowsley, in press).

One of the more interesting pieces of work to emerge from this program is the fabrication and testing of a sophisticated energy balance measuring device by Dr. Harry McCaughey (in press) of Queen's University. The system includes:

1) Reversing temperature difference measurement system (RTDMS)
2) Thermopiles for the measurement of dry-and-wet bulb temperature differences
3) A net pynadiometer
4) A tipping bucket rain gauge
5) A data-logger
6) A recording wind gauge

The system measures the total energy entering a site, and the amount leaving the site - the difference between the two is the amount remaining for plant growth. The advantage of this system is that data can be recorded continuously over long periods of time (months).

It has the ability to quantitatively measure differences in growth potential between sites. The plan is to use the system to match willow clones to site.

FUTURE WORK

One of the main purposes of the program is to demonstrate the economic and technical feasibility of producing biomass using the energy plantation concept. The existing test plantations will be expanded annually for a few years and growth will be monitored until some reliable yield values are obtained.

Scandinavia and Canada are developing prototype energy-crop planting and harvesting machinery which may be tested in Newfoundland when they become available. In the meantime manual planting and harvesting will be used.

The energy-balance system will continue to provide useful data from the various plantations.

OTHER CANADIAN STUDIES

Newfoundland is the only Province testing energy plantations in the Boreal Forest Region of Canada. In southern Ontario, the hybrid poplar program is being expanded to include trials of Salix and Alnus spp. This latter genus is being tested as interplantings with other species to promote natural fertilization through biological fixation of nitrogen. These trials are too new to draw definitive conclusions regarding N-fixation. Recent studies under Dr. Louis Zsuffa at the University of Toronto have evaluated the effects of interspecific hybridization in the improvement of yield and quality of native North American willows. This work is continuing under an ENFOR contract.

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